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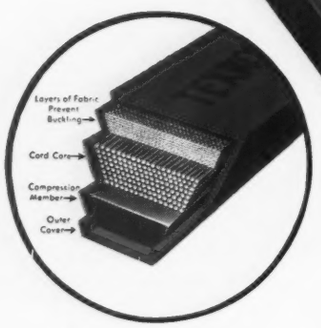

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MAINTENANCE ENGINEERING

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1 9 3 2

Long Life for Plant Windows

STANLEY C. HUNTER

Maintenance Counselor, The Tremco Manufacturing Company
Cleveland, Ohio

WHEN transparent masonry is discovered one of the most perplexing of industrial plant problems will be solved. Until that time property owners must continue trying to unite masonry, steel, and glass in a way that will compensate for the wide variation in their coefficients of expansion and contraction. As it is not probable that a suitable substitute for windows will be discovered, much attention is being given to the matter of maintaining windows at a reasonable cost.

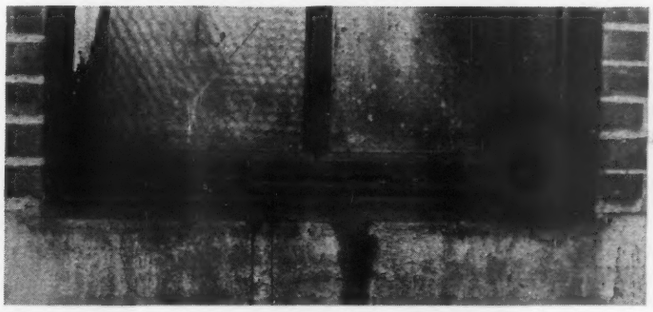


Fig. 1—Rust and rot thrive where environment is damp and maintenance is lax. Shown is a combination metal and wood sash in need of replacement after nine years of service under such conditions.

The plant owner who sets his steel sash in masonry cannot expect more than twelve years of service from them even if the moisture and fume conditions around his plant are negligible. Where moisture and fumes exist to an appreciable extent the average life of factory sash, as they are installed commonly, is much less than twelve years. An accompanying illustration shows what rust and rot have done in nine years to a combination metal and wood sash.

Deterioration begins immediately after window sash are set. When sash are set directly against masonry surface such deterioration is accelerated. In the case of steel sash the alkali in the masonry attacks the metal and soon eats into the steel through the protective coat of paint. When sash are set directly in the masonry it is impossible, of course, to repaint the imbedded surface, and the moisture present in the masonry aggravates the damage already done by creating a rust condition. This attack usually occurs at the outdoor line of contact between the sash and the masonry although it also strikes at the indoor edge of the sash when much moisture exists within a building. Painting exposed surfaces of sash seems to retard their deterioration but little because the rust condition set up where steel meets masonry creeps under the paint and causes the paint to leave the steel in a few weeks.

Where window sash are of wood they deteriorate somewhat more slowly because of the less harmful effect of the alkali in the masonry on

wood. It is more difficult, however, to make a tight joint between wood and masonry than when steel sash are used. Driving rains enter easily behind wood sash where they set up a rot condition which soon destroys the paint coat on both inside and outside surfaces.

It is a simple matter to safeguard wood sash because the openings between masonry and sash can be sealed permanently against the infiltration of moisture from either the exterior or interior of a building, or from the effects of dirt or cold from outside. It is this infiltration that ruins interior decorations, destroys sash, and disintegrates adjoining masonry. The proper method of sealing the openings is to insert beads of permanently elastic calking compound between the sash and masonry surfaces. This material should be forced at least one-half inch into the opening and should leave an exposed surface of the material about one-half inch wide over the opening to take care of future contraction and expansion. The exposed surface of this bead should be convex in shape in order to provide ample material to care for the shrinkage caused by the tough skin that forms on the surface of the compound. This skin seals in the life-giving oils that cause this compound to remain permanently plastic.

Steel sash also should be treated in the same manner where the steel meets the masonry. With steel sash, however, another problem is encountered because of the fact that the sash frequently are set directly in cement mortar as shown in an accompanying illustration. Such construction leaves no opening to be filled with a protecting and cushioning layer of bedding compound.

This problem is solved successfully by filling the recesses in which sash are to be set with a heavy bedding compound that is rich in the type of slow drying oils that keep the material from becoming hard and brittle. The compound provides a cushion between two unyielding materials such as steel and masonry, seals out dirt and moisture at vulnerable points, and beds the steel sash in a material that is unaffected by the alkali in masonry. Furthermore the sash is protected from the rear where it cannot be repainted, and moisture is prevented from entering from behind.

When moisture gets in behind sash it migrates through the masonry toward the outer and inner walls of the building. The result is that stains, caused by the evaporation of the salts brought to the surface by the moisture seeking exit, are left on the walls. Because steel and masonry expand and contract at different rates the bedding compound serves to prevent damage to the sash and adjoining masonry and provides a permanently elastic seal against openings.

So far I have discussed only the joint between sash and masonry. There remains the matter of a suitable union between the window glass and sash, whether the sash is of steel or wood.

Where no concern is felt or attention paid to this problem a material commonly sold as putty is used. It usually is a mixture of cheap oil and some chalky or metallic pigment. Such a material soon dries out so that it is left in a hard and brittle condition. The result is that it either breaks loose and drops off if movement takes place in either glass or sash, or it adheres to the joint so securely that no movement of the glass is allowed. The latter condition frequently causes the glass to break.

Replacing broken window glass increases maintenance costs considerably because often more time is required to remove old putty than to set a new glass. Damage to the sash always accompanies such replacements because it is necessary to use a chisel and hammer to remove this flint-like material. This inferior product is not impervious to moisture and fumes and therefore has an extremely short life on sash of factories around which steam or acid fumes exist. In northern latitudes moisture condenses on the inner surfaces of the windows in cold weather and seeps between the glass and the putty if the sash are of steel, or between the glass and the rabbets if the sash are of wood. The moisture soon loosens the putty and destroys the sash whether by rust or rot, or both.

Fig. 2—An unsatisfactory method of installing steel sash is to set them in cement mortar as shown. The mortar soon cracks and falls out, thus accelerating deterioration.

Insurance against the faults previously set forth can be effected if the property owner will ask his architect or building contractor to make the necessary provisions while a building is in course of construction. On standing property it remains for the plant maintenance engineer to take what steps he can to correct mistakes that were made when the building was erected. Such steps consist of reglazing all windows as the necessity arises with a high grade glazing compound that will not set up hard, crack, or drop off, and that can be removed at any time with a putty knife as well as be unaffected by moisture, fumes, heat, and cold. If sash have not deteriorated to a hopeless extent the maintenance engineer may prolong their life considerably by calking between the sash and the masonry in the manner described previously.

Although a plastic material is used to overcome the difficulties encountered when maintaining steel or wood sash in factories it does not follow that all plastics made for

this purpose are suitable. Neither does it follow that the same plastic will serve at all points. For bedding steel sash when installing them in masonry a heavy-bodied material rich in combination of extremely slow drying oils is recommended. This material will not stain even such a porous stone as limestone. It must be heavy enough in body to serve as a cushion between the steel and the masonry, yet it must contain a fluff pigment with enough affinity for oil to hold the oils in the material. Such a material retains its plasticity indefinitely and will not allow its oils to escape into the adjoining sponge-like masonry. The plastic also must be adhesive enough to make an elastic bond between the steel and the masonry, yet it must not be sticky or workmen will find it difficult to apply.

Where sash are not bedded in a plastic and it is desired to give them maximum protection another type of plastic is used in the form of a bead around the joints where sash meet masonry. This installation forms a weatherproof seal between the sash and the masonry that keeps out dirt, air, and water.

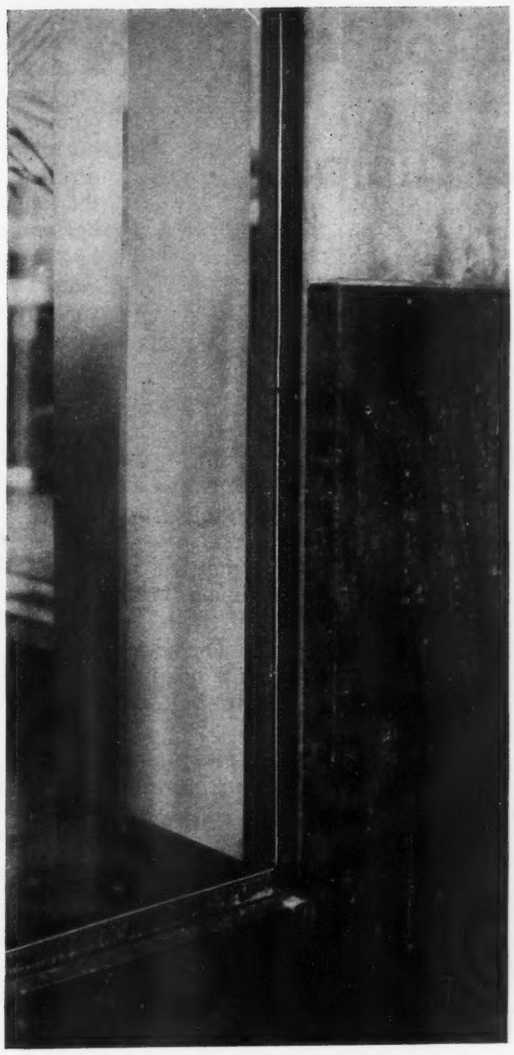


Fig. 3—An excellent job of plastic calking has been performed on all of the steel sash illustrated except the window ledge where the paint is peeling after only a few months' service.

Water at these points frequently freezes, ruining the sash and disintegrating the adjoining masonry. This moisture also causes discoloration of the masonry and allows the alkali in the masonry to attack the steel sash. The plastic should be applied with a pressure gun so that the material may be forced into any openings that exist between sash and masonry and a neat, attractive job is secured. Fig. 3 shows the first step in the deterioration of uncalked steel sash. The vertical side of this sash was calked properly, but false economy caused the owner to neglect the sill. The result can be plainly seen: The paint is leaving the sill after only six months' service.

The third plastic to be used is one made especially for glazing. In addition to possessing the features of the other two compounds, it should be made to contain a certain amount of volatile vehicle. This ingredient will escape shortly after application of the compound. Therefore the plastic will set up rapidly after application so that the windows may be washed at once with little danger of disturbing the finished job of glazing.

When this compound is used with wood sash it should contain a pigment with an affinity for the oils in the finished product in order to prevent the escape of the oils into the wood. Furthermore, the oils used in the manufacture of this material should be such as to produce a tough, elastic film over the outer surface of the compound when it is dry. This film permits painting of the sash at once; seals in the life-giving oils; and protects the finished surface from moisture, acid fumes, and injury from abrasion. Such a product should be procurable in two consistencies: one quite firm for those who do their own glazing; and one somewhat softer for the use of professional glaziers. Neither consistency of the material should require kneading or other preparatory operations when it is taken from the container for application on the sash. Neither of them should be found to dry out if allowed to remain unused in an open container.

Intelligent application of the information and suggestions presented in this article should result in a reduction in maintenance costs of plant windows, whether the plant is new or old.

■

The Relation of Torque to Tension For Threadlocking Devices

Research Paper No. 386, reprint from Bureau of Standards Journal of Research, Vol. 7, November 1931, by H. L. Whittemore, G. W. Nusbaum, and E. O. Seaquist, of the Bureau of Standards. For sale by Supt. of Documents, Washington, D. C., 30 cents.

THIS investigation was made to determine, under static loads, the torsional resistance to unscrewing of nuts, with and without locking devices, and the relationships these torques bear to the stresses in the bolt. The torque required to produce given stress in the bolt was also determined for each device.

Twenty-four manufacturers of threadlocking devices accepted the invitation to submit samples of their devices.

A total of 41 devices was tested, including such devices as standard nuts, jam nuts, and slotted nuts with cotter pins.

Variations in the dimensions of the threads, either on the bolt or in the nut, would be expected to affect to some extent the torque-tension relationship, but no method of measuring the errors in lead or of the thread contour was found which could be used on all the devices.

As it was believed that differences in the dimensions of the threads sufficiently great to affect the torque-tension relationships would be indicated by measuring the diametral clearance between the nut and the bolt when assembled, and the obliquity of the bearing face to the nut, these measurements were made on all ordinary nuts and on all the other devices on which it was practicable. These values were used to determine whether the ordinary bolts and nuts complied with the purchase specifications.

Only about one-quarter of the devices showed any appreciable difference in the static torque-tension relation from that of the American National coarse-thread standard nut.

Finding Jobs for Idle Centrifugal Pumps

R. H. PARRISH
Electrical Engineer, Mission, Texas

WHEN there is an idle centrifugal water pump about the plant it often is desirable to know with what success it could be used to do another job that is needed at the time, such as pumping brine, gasoline, or oil.

Although there are several points that must be considered to determine definitely whether the new application for the pump is practical, in a surprisingly large percentage of cases it will be found that the pump on hand adapts itself to the new liquid with only a slight sacrifice, if any, in efficiency or length of life.

The first consideration should be to determine whether or not the material of the pump is such that it would be attacked and destroyed by the new liquid to be pumped. The following table lists some of the most common liquids pumped, together with the corresponding materials used in the pump construction:

Kind of Liquid	Pump Construction
Alkaline water	All iron fitted
Ammonia water	All iron fitted
Brine	Bronze fitted
Acid water	All bronze fitted
Gasoline	Bronze fitted
Petroleum	All iron fitted
Water	Bronze fitted

If it happens that the construction of the idle pump is suitable for pumping the proposed liquid other important points must be considered. One next wants to know whether the motor or engine formerly used to drive the water pump is of sufficient size or is too large to be used. As a matter of fact the horsepower necessary will be in direct proportion to the weight of the liquid as compared to that of water for a given static head and quantity. Assuming that 5 hp. was required for pumping a given quantity of water, then 5x0.8 or 4 hp. would be required to pump the same quantity of gasoline with a specific gravity of 0.8 against the same static head or elevation. Again, suppose it is desired to pump brine with a specific gravity of 1.2 to an elevation of 50 ft., using a pump designed for pumping water at a total head of 50 ft. Such a pump will be equally suitable for pumping brine provided, of course, that it is of bronze-fitted construction. The power necessary to pump the same quantity of brine as water would be 5x1.2 or 6 horsepower.

In order to obtain a clear comparison between one pump handling water and another identical in design handling gasoline with a specific gravity of 0.8, assume that both machines are pumping against a 50-ft. static head that consists of a vertical discharge column. After the pumps are started and run at the same speed under the same conditions, it is observed that the liquid rises to exactly the same height in the discharge columns.

This phenomenon is due to the fact that the weight of the liquid does not enter into the velocity head created by the pump and reveals a very important characteristic of the centrifugal pump: The pump will deliver its rated capacity of any non-viscous liquid where the discharge static head is the same. Therefore a water pump good for a 50-ft. total static head would be equally good for the same 50-ft. head when pumping any other non-viscous liquid.

The difference in the weights of the two liquids will show up when a pressure gage is placed on the discharge side of each pump. The gage will show pressures of 50x0.43 or 21.5 lb. per sq.in., and 50x0.43x0.8 of 17.2 lb. per sq.in. at the water and gasoline pumps respectively It also will be noticed that both pumps are discharging the same volume of liquid. This observation brings to light another important fact: The same volume of liquid will be pumped when different non-viscous liquids are pumped under the same conditions because it will be remembered that, at a given speed, the pump always will produce a constant static head. The pump discharge pressure and required horsepower will, of course, vary directly with the specific gravity of the liquid.

For liquids of thick consistency it has been found that, compared with water, a pump will deliver a smaller capacity and will require more horsepower to drive it. Such inefficiency is due principally to the higher internal friction in the pump caused by the viscous liquid being pumped.

Suppose one has on hand a water pump, designed for a 100-ft. or 43-lb. per sq.in. total head, which he desires to use as a gasoline pump. Against what pressure will it deliver its rated capacity when pumping gasoline? The answer is arrived at by recalling that the static or pressure head remains the same, which means that under these conditions, it would produce a pressure equivalent to a static head of 100 ft. of gasoline, or 100x0.43x0.8 or 34-lb. per sq.in. pressure. Should it be desired to make the pump deliver the same capacity of gasoline against a 43-lb. sq.in. pressure, it could be made to do so by increasing the peripheral speed of the impeller in the ratio of 43 to 34, either by increasing the speed of the pump or replacing its impeller with one of larger diameter.

The safe suction lift of the pump will vary inversely as the specific gravity of the liquid pumped. That is, if a pump will lift water vertically 18 ft., it also will lift petroleum with a specific gravity of 0.9 a distance of 18 divided by 0.9, or 20 ft. In like manner the pump will lift brine with a specific gravity of 1.2 a distance of 18 divided by 1.2, or 15 ft. In addition the maximum safe suction lift of a centrifugal pump will vary with the size of the pump, viscosity of the liquid, temperature, and altitude. Hot water and heavy, viscous, or vaporizing liquids should flow to the pump under a positive pressure head.

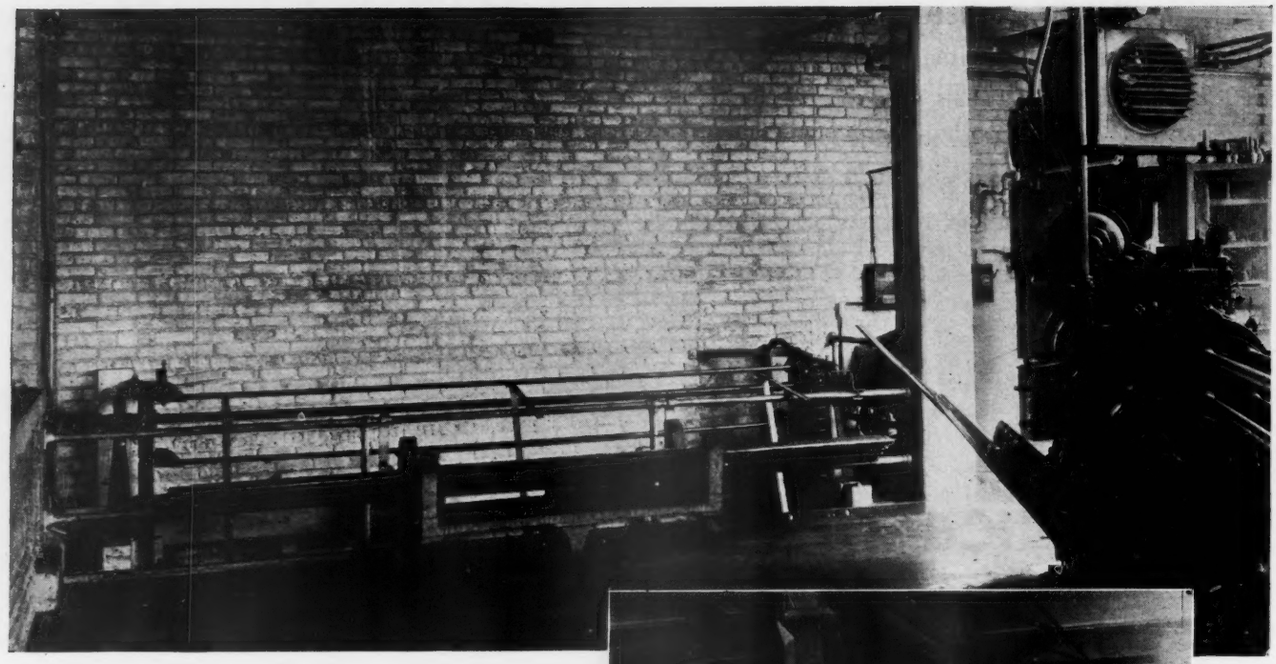
By way of a summation the capacity of a centrifugal pump varies directly with the speed. The total head varies with square of the speed. The required horsepower varies with the cube of the speed. The required horsepower for two identical pumps will vary in direct proportion to the specific gravity of the two liquids pumped. Static head and volume of liquid pumped remain the same regardless of the non-viscous liquid being pumped, other things being equal.

Much stress has been placed in recent years on complete systems of equipment that entirely lift the job of handling materials from the workers and revolutionize their plants' production methods. Unfortunately such large systems cannot be applied economically to the majority of industrial plants in this country today because of limitations imposed by the materials to be handled, or the arrangement of buildings. But handling equipment in small units can be applied in such plants with excellent results as shown in the accompanying illustrations—the third group in a series.

Small Applications of Handling Equipment

A small belt conveyor does a large part of the corn-sorting job in the plant of Morgan Brothers, Galva, Ill. From the sheller the corn from each ear is deposited on the moving belt conveyor in a separate pile. Sorted piles are dispatched by manipulation of a lever which changes the position of the slide at the end of the belt.

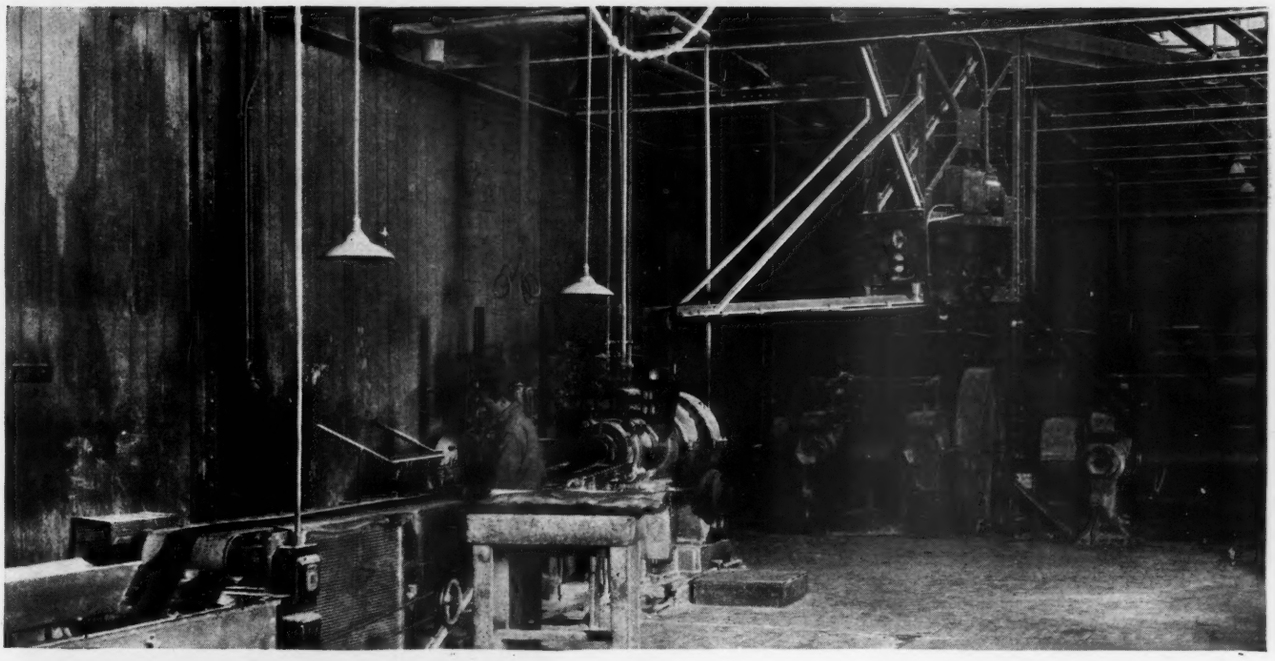
Before the introduction of a portable loader it took four men one day to load a freight car with 100-lb. bales of steel scrap at the plant of the Benjamin Electric Company, Des Plaines, Ill. The loader now does the same job in half a day and requires the assistance of but two men.



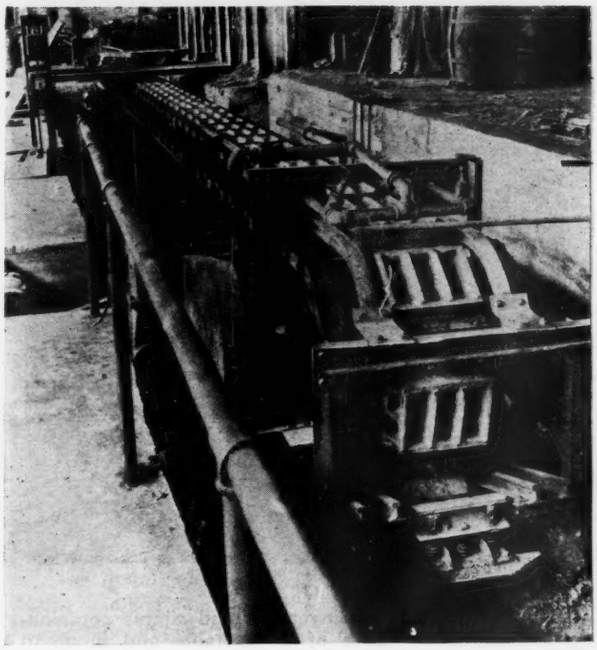
Bar stock in sizes up to 2¼-in. diameter and 12 ft. long now takes the straight-line route from the receiving department to the screw machines on an upper floor of the plant of the Appleton Electric Company, Chicago, Ill., by means of an automatic chain-type elevator. Both loading and unloading are automatic. The stock is delivered onto the wheel truck shown.

Labor costs were reduced 60 per cent by the installation of a conveyor system and its attendant equipment in the packing department of The Carborundum Company, Niagara Falls, N. Y. Packed boxes, barrels, and cartons are delivered to the head of the gravity roller conveyor shown, by a slat conveyor along which are stationed the packers, from which point they are transported through a nailing machine and scale to the shipping floor.

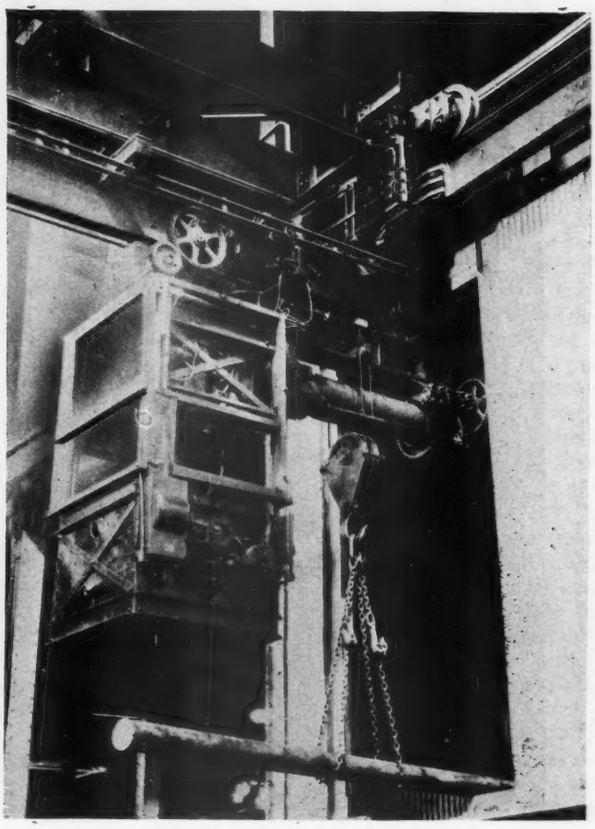
Bricks are loaded onto the trays of an overhead chain conveyor at the kiln cars and are carried either to yard storage or directly to trucks for shipment at the plant of the Buffalo Shale Products Company, Jewettville, N. Y. The arrangement of equipment permits many trucks to be loaded simultaneously. Shortly after its installation the loading crew was greatly reduced.



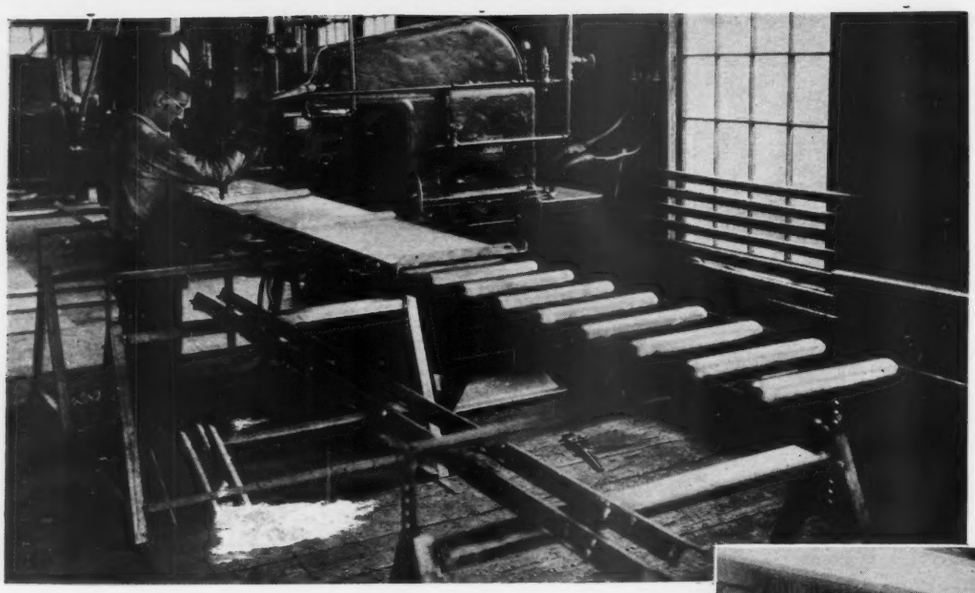
A continuous strip of rubber is carried from a warm-up mill to the mouth of an extruder by an overhead belt conveyor in the inner-tube shop of The Dunlop Tire and Rubber Corporation, Buffalo, N. Y. The capacity of the extruder was tripled through the steady feed of rubber made possible by the equipment. Standard pillow blocks and a spur-gear reduction unit are used.



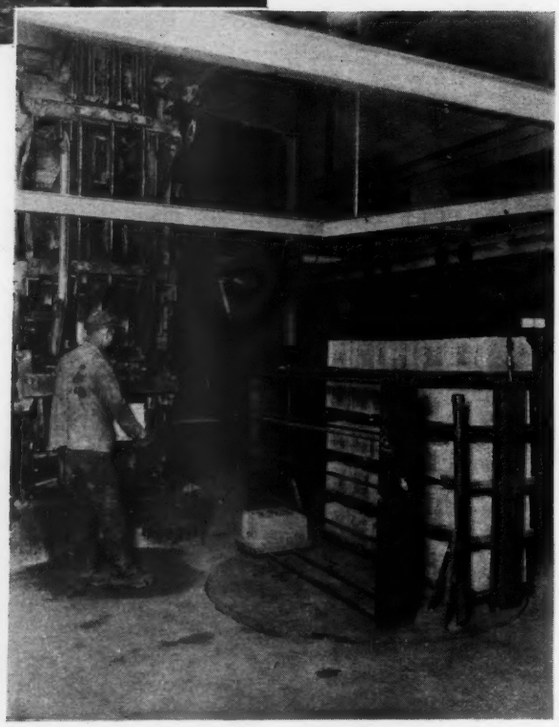
R. Lavin & Sons Company, Chicago, Ill., found that it could mold 20-lb. copper ingots at the same rate with twelve less men after the installation in its plant of a 50-ft. apron-type conveyor equipped with cast-iron molds. The molds are filled by triple spouts at the smelting furnace in the background while the conveyor is in motion. When the molds strike the steel rail equipped with heavy springs in the foreground, the ingots are knocked out into a continuous cooling tank.



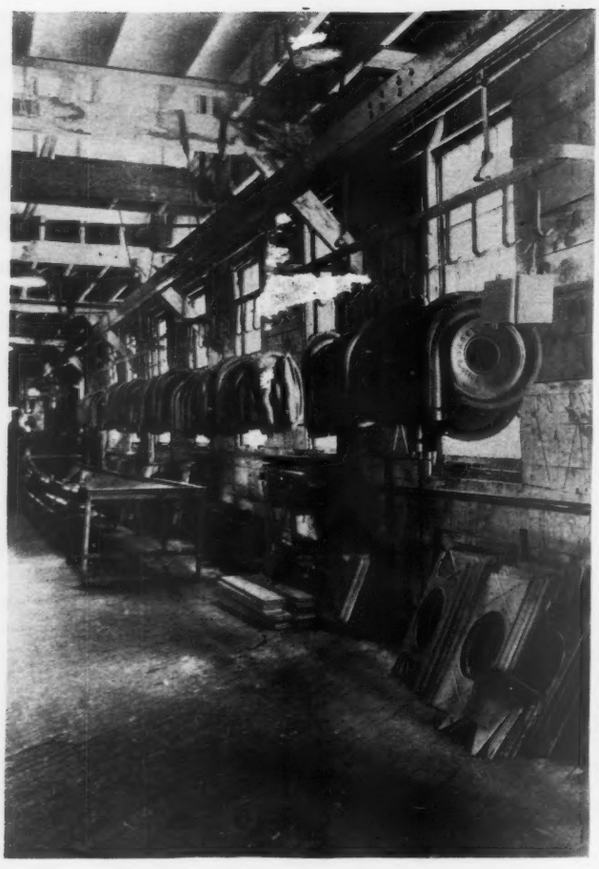
At various transfer points the hoist and control cab of a 5-ton electric crane in the plant of Jos. T. Ryerson & Sons, Inc., Chicago, Ill., can leave its bridge and travel on a monorail track to serve areas not covered by cranes. The illustration shows the hoist and cab about to enter a heated storeroom for cold-finished steel. The door opens and shuts automatically, being operated by a small motor controlled in the cab.



Faster and more economical welding resulted from the use of a length of portable roller conveyor equipped with adjustable supports in the plant of the Mathews Conveyer Company Ellwood City, Pa. The sheet metal to be welded can be moved about easily on the roller table as required by the specific job.



An ingenious and simple combination of a turntable and monorail track equipped with a special trolley and hoist carries concrete blocks from the molding machine to a kiln in the plant of R. E. Hamilton's Sons, Detroit, Mich. In the illustration the loaded rack is about to be picked up and carried to the kiln. When the rack on the left is full, the turntable is revolved a half turn so that an empty rack is presented to the machine and a full one to the hoist.



By use of a special type of monorail conveyor installed in the plant of the Buffalo Forge Company, Buffalo, N. Y., pressed-steel fan casings drip for 20 min. over a basin and then are moved along to dry for 4 hr. in a minimum space without the necessity for rehandling.

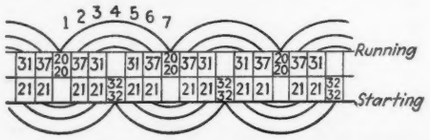
Around the works . . .

Readers are invited to submit descriptions of practical methods devised to meet specific operating conditions. The items may refer to details of installation, inspection and testing for maintenance, wiring, repair, and replacement

Rewinding Single-Phase Motors for Three-Phase Operation

WE HAVE a number of small unit heaters in our plant, each of which is provided with a ½-hp., single-phase, 110-volt motor to drive the blower. The centrifugal switches on these motors were giving us considerable trouble because dust interfered with their action. As a result several starting windings burned out, and this trouble was followed by failure of the running windings. Of course the motors could not start without the starting windings.

I decided to rewind the motors for three-phase, 220-volt operation. A set of coils was made up in accordance with the accompanying data. After finding



Original winding diagram of the single-phase motor which was rewound for three-phase operation

that the first motor functioned perfectly I rewound several of the others in the same manner.

In designing the new coils the following method was used: Taking the average number of turns in the running winding—

20 slot 1 turn
37 " 2 "
31 " 3 "
—
88 ÷ 3 = 29 average turns

This number of turns was then doubled (60 turns to use round numbers) in order to allow for the doubling of the voltage. Wire was used which was half the size originally employed; that is, for the No. 18 wire originally used No. 21 was chosen. Upon attempting to wind with this size of wire the coil was found to be too large so I used No. 23 wire. A coil of 60 turns of this wire was found to be just right because the slot was filled when two half coils were in position. I used a coil span of one to six which is one slot under full pitch. The winding was connected, single-circuit star, six-pole for three-phase operation and is functioning in a very satisfactory manner.

No attempt was made to go into more technical calculations. Possibly the winding could be made more efficient, but the result is satisfactory to us.

CHAS. A. PETERSON.

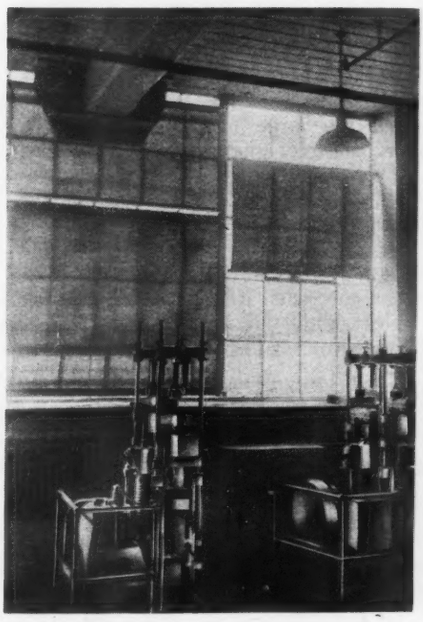
Mishawaka, Ind.

■

Intermediate Beam Support Increases Window Area

AN UNUSUAL type of reinforced concrete construction is shown in the accompanying illustration. When laying out our shoe factory we decided to obtain, in addition to maximum daylight illumination, a rigid structure of reinforced concrete provided with a slow-burning, mill type of interior construction.

Although we designed the exterior pilasters for 20-ft. bays the interior columns were spaced on 10-ft. centers. By referring to the illustration it can be seen that an intermediate beam is hung by a steel bracket from the concrete lintel, while the beam supported by the pilaster is set in a beam pocket. The reason for hanging intermediate beams in this manner is to obtain additional window area.



Suspending the outer end of an intermediate beam from a lintel as shown eliminates the necessity for a column and therefore increases the window area.

Ordinarily the bottom of the concrete lintel would be located below the intermediate beam, which construction would drop the bottom of the lintel flush with the bottom of the angle iron bracket supporting the beam. But, if we had used this construction, we would have sacrificed two lights of glass the entire length of the building.

By adopting this construction we increased the window area enough to obtain sufficient daylight illumination to operate the most intricate machinery in the factory. K. D. HAMILTON.

Mechanical Department
Geo. E. Keith Company
Campello, Brockton, Mass.

■

Deeper Threading Reclaims Defective Nuts and Bolts

DURING the course of mechanical maintenance we often run across bolts and nuts of standard size that are not a perfect fit because the threads of the nuts are not deep enough. In such cases it is desirable to salvage the defective parts if possible. By selecting a tap slightly larger than the standard nut size (but of the same thread and pitch) the nut may be retapped to provide a looser fit. This procedure of course requires that a number of taps be kept in stock and, more often than not, we do not have the proper size.

This method may be improved upon by a simple but effective measure. Select a tap of the standard size and thread that corresponds with those of the nut to be salvaged. Of course this tap will fit tightly into the nut, but it will not cut deeper into the thread. Now around this tap wrap a layer of ordinary twine, being careful not to make too heavy a layer. In many cases ravelings from waste rags will do the job as well as the twine. With the tap wrapped

in this manner run it through the nut. The result will be that the threads will be cut deeper, yet the thread pitch will not be affected.

By practice it soon will be learned how much thread or twine will be required to produce a given result. This method also may be used to deepen the threads of a tight fitting bolt hole.

Tapoco, N. C. C. B. STOUGHTON.

■

Salvaged Pipe Bends Utilized for Pipe-Line Supports

IT WAS decided to use a number of salvaged 180-deg. return bends of 2- and 3-in. pipe as pipe-line supports. To support a 4-in. overhead line 3-in. bends were cut off to make a semicircle and welded to 3-in. pipes of the required length, as shown in Fig. 1. The ends of the pipe then were welded to steel flanges which, in turn, were bolted to a concrete footing. The footing was poured so that it was a few inches above grade. The center of each bend next was drilled to receive a ¾-in. eyebolt which was bolted to a standard pipe clamp. This arrangement provided for lateral expansion of the pipe.

Where it was necessary to run a 3-in. pipe line along the top of a fire wall,

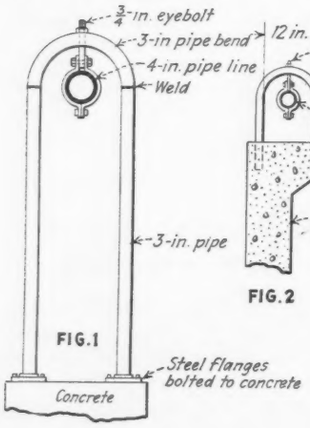


FIG. 1

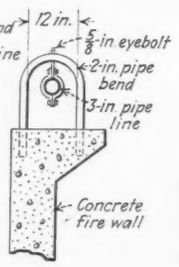


FIG. 2

the lip or edge of the wall was poured wider than was called for originally in order to accommodate the radius of the 2-in. bends used, as shown in Fig. 2. The bends were drilled for ⅝-in. eyebolts before they were cast into the top of the wall. M. C. COCKSHOTT.

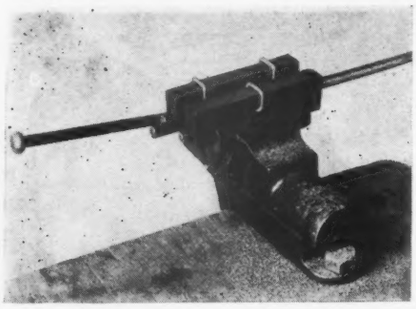
Arcadia, Calif.

■

Rod Straightening Vise Fixture

REPAIRMEN often have to straighten light shafts and rods in the vise. The usual method is to hang three pieces of bent drill rod vertically on the inside of the vise jaws so that two rods are on one jaw and one rod on the other. By adjusting the position of the drill rods horizontaily to suit the kinks in the shaft the bent member is straightened by applying pressure with the vise.

As a practical repairman I have used this method often, but it has been my experience that the three pieces of drill rod would fall on the floor at the least



Much time can be saved when straightening shaft or rod by using a special fixture that cannot fall apart.

touch. I decided therefore to make a fixture that could not come apart. After machining two pieces of steel to fit the vise jaws I tapped them for tightening screws as shown in the illustration. Then I bent the three drill rod adjusting pieces around these two blocks as indicated so that they cannot fall off, yet they can be adjusted horizontal y. The fixture can be packed in a toolbox.

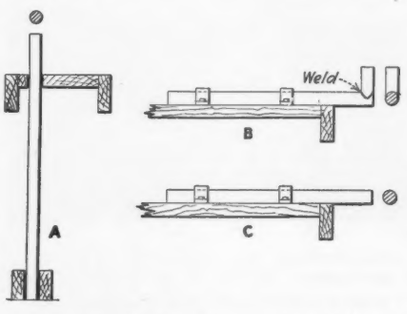
Hamilton, Ont., Canada H. MOORE.

■

Shafting as Bench Anvils

I HAVE found that short lengths of shafting make ideal bench anvils. I have used them to advantage in three different ways. The first of these is shown in A. A hole is bored in the bench top large enough to permit a short piece of shafting to be dropped through it. Then a wood ring is provided directly below the hole in the bench as shown.

Sketch B shows how the same type of anvil may be supported from the bench top when it is necessary to keep a clear floor. It is anchored in place by two iron clamps. The short piece of



Three methods of mounting shafting for use as bench anvils.

shaft is hollowed out to fit over the other, and the two are welded together as shown. An anvil of this type is especially helpful when riveting ears to pots and buckets on repair jobs.

For many types of service, such as riveting tapered pipe and forming curved metal, a straight piece of shafting mounted horizontally on the bench as shown in C best fills requirements.

An important advantage in favor of the use of shafting as bench anvils is that it may be removed from the bench and stored out of the way until needed again. JOHN E. HYLER.

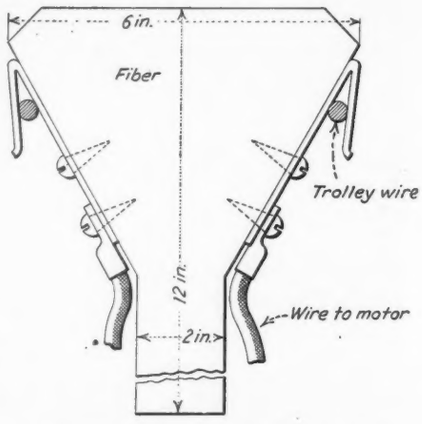
Peoria, Ill.

■

Connectors Simplify Line Tapping for Portable Tools

AFTER a crane had been installed in a department of a certain plant, power to operate a number of portable tools was required.

To provide d.c. power for the crane two bare No. 0 wires were strung parallel to the runway about 6 in. apart. The portable tool users immediately



A fiber connector facilitates the tapping of a crane circuit to obtain d.c. power to operate portable tools.

took advantage of the convenience that these wires provided as a power supply. Leads from the tools were bent and looped over the crane circuit for intermittent periods. This method was slow, dangerous, and delayed operation of the crane. A connector, shown in the accompanying sketch, was made to eliminate this trouble. By its use the operators can make and break the circuits safely and rapidly. It consists of a piece of ¾-in. fiber made up to clip on both crane wires simultaneously.

In another instance several three-phase drills were in use in a quarry. To get power to the drills the operators had to climb a pole to loop the leads over the feeders. If the connections were made so that the direction of rotation of the drills was incorrect the operators

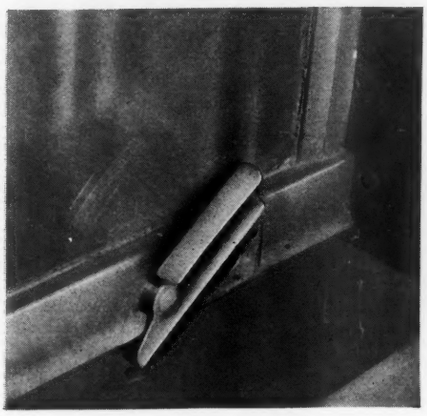
had to climb the pole and reverse the connections. To simplify this operation three-wire plug connectors were installed on the pole so that all the operators had to do was to reverse the connectors on the tool ends.

Modifications of these connectors have been used from time to time to suit varying conditions.

CHAS. A. PETERSON.
Mishawaka, Ind.

■

Lever Grips for Windows



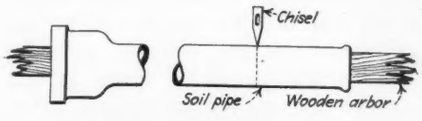
Hand grips that exert a levering action on the sill make easy work of opening obstinate metal windows. Two grips are used on each window.

■

Cutting and Inspection Methods for Cast Iron Soil Pipe

SOIL pipe usually is made of very hard cast iron; therefore it is difficult to cut with a diamond-point chisel. Some engineers prefer this method of cutting because it leaves the end of the pipe neatly beveled. But beveled ends are not essential to a good joint. The calked lead will clamp the socket of a square end joint firmly enough to resist any ordinary stress tending to pull it apart.

An easy and effective way to cut the pipe follows: Hang it on a round



Shown is a simple method of cutting soil pipe by means of a wooden arbor, chisel, and sledge hammer.

wooden arbor as shown in the sketch and nick it around its circumference with a blacksmith's cold chisel by striking the chisel with a light sledge. The pipe then can be broken off clean and square by striking it a sharp blow on one end. This method saves much time and labor in cutting soil pipe of large diameter.

New soil pipe should be examined for sandholes, flaws, and cracks. A crack may be detected by tapping the pipe with a light hammer. A sound pipe will ring clearly when struck, but a cracked one will emit a dull, jarring sound. The wall of the pipe may be excessively thick in one half of its periphery and correspondingly thin in the other. The test for such an irregularity is to tap the pipe here and there with a hammer. The thin places, if any, will ring at a higher pitch than the thick ones. Blowholes and other flaws can be detected similarly.

St. Louis, Mo. J. A. DIXMUND.

■

Defective Transformer Causes Unbalanced Current in Motor

WHILE employed as "trouble-shooter" for an electrical contracting company I ran across many cases of electrical trouble caused by mechanical as well as electrical defects. Defects in one piece of apparatus often showed up in another, whereas the defective apparatus appeared to be functioning perfectly.

A case of this kind was found at an ice cream manufacturing company located in Birmingham, Ala. A 25-hp. motor had been rewound about six months previous to the customer's complaint that the motor was drawing too much current on one phase. The customer had obtained this information from the power company. The meter men had found the unusual condition during their regular tests and had reported it to the line department. After testing apparatus was sent over and used the motor driving the refrigerating machine was pronounced defective.

When the complaint came in to our company I was sent over to investigate the trouble. I took with me a split-core current transformer with an ammeter calibrated with it, a 600-volt a.c. meter, a magneto, and a test light. I found that the motor current was unbalanced. Phase one read 33 amp.; phase two read 56 amp., and phase three read 65 amp. I also found that the voltage was 25 volts low on one phase. This voltage variation was the clue. I desired that the voltage be corrected before checking the motor windings. However, the management of the company insisted that we check the motor connections.

We knew from the rewinding data that the motor should have a six-pole, double-delta connection. There was a possibility that part of one phase might be reversed, but this fault was not probable because a motor in this condition generally emits abnormal sounds when operating with any load at all, and the motor had been running satisfactorily for about six months. The connections were checked and found to be correct. We advised the power company of this fact and suggested that they check the transformer station. They were ready to cooperate and sent a man to check the transformers. One transformer was found with a defective winding, and it was replaced immediately.

We tested the equipment again and found that the voltage did not vary 3 volts between phases. The current was tested at the motor. This test indicated two things, one was that the motor was O.K and the other indication was that it had very little load after starting the compressor which it drove. The phases indicated from 42 to 45 amp. The full load current of this motor at 220 volts is 61 amp. This incident shows the value of the intelligent use of simple testing instruments in locating unusual trouble in equipment.

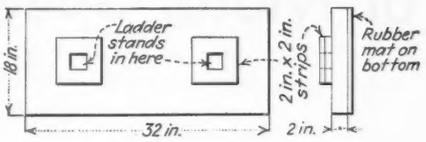
GRADY H. EMERSON
Birmingham, Ala.

■

Safety Stand Restricts Ladder Movement

THERE is always danger in using a ladder that is not provided with some means of preventing it from slipping.

A device for preventing such slippage, the use of which I believe to be more effective than that of pointed steel



prongs, is shown in the accompanying sketch. It consists of a wooden base provided with wells in which to place the ladder feet and a bottom covering of corrugated rubber matting.

Denver, Colo. R. M. THOMAS.

■

Removing Hard Greases from Machinery

TO REMOVE hard greases and oil from machine parts preparatory to repairing them, add ½ lb. of caustic soda to 2 gal. of water and boil the parts to be cleaned in the fluid. If the parts are too big for this procedure boil the fluid and apply it boiling hot to the parts with a stiff brush. This mixture can be used safely many times before it loses its strength, is inexpensive to make, and is quick and sure in action.

CHARLES R. WHITEHOUSE.
Standards Engineer
The Holtzer-Cabot Electric Company
Boston, Mass.

Close speed control of a motor or fleet of motors is obtained by applying the variable voltage of an individual generator to the motor armatures.

E. C. DIEFFENBACH

Industrial Engineering Department
General Electric Company
Schenectady, N. Y.

Sectional drive of a paper machine operating at 100 to 1,000 ft. per min. Generator-voltage control provides the speed regulation of the fleet as a whole from a master rheostat, and individual control maintains the speed ratio between the couch, press, dryer, and calender rolls to secure the proper "draw."

Variable Voltage Control of Motor Speed

AS ONE writer aptly expressed it, generator-voltage (Ward-Leonard) control is an "iron hand in a velvet glove." By producing comparatively small currents units up to several thousand horsepower are protected and controlled as to power output, speed in either direction of rotation, and dynamic or regenerative braking torque. It is one of the smoothest control systems known to the electrical industry and is readily adapted to any source of power supply.

A simplified generator-voltage control system consists essentially of two parts, viz., a driving element, usually consisting of a steam turbine, a.c. or d.c. motor, and a d.c. generator. The reader is invited to follow a typical starting cycle: The operator starts the d.c. generator (B) Fig. 1 by starting the motor (A) or other source of power (steam turbine, internal combustion engine, or the like). This operation is completely without any field on the d.c. generator, and consequently no torque need by supplied by the motor other than that necessitated by friction and windage. After the generator is up to speed he is ready to start the motor (C) attached to the load. He applies a field current to the generator, which is now rotating at full speed, by closing the switch and manipulating the field rheostat. The motor (C) starts up slowly or rapidly as he wishes. Thus a smooth velvet-like flow of power is supplied without shock or jar to connected mechanism, which can furnish either direction of rotation, and is obtained without material rheostatic losses. The fact that the voltage is built up gradually during the period of acceleration instead of being thrown on at maximum is largely responsible for the longer life and reduced maintenance of apparatus associated with this type of control.

Generator-voltage control is most frequently used with alternating current supply. The motor-generator operates at full speed continuously and the d.c. motor or motors driven by the generator may operate at any speed from zero to maximum in either direction of rotation. There are available alternating current motors which have considerable speed range; but generator-voltage control provides service that cannot be given by any a.c. or d.c. motor under any other control system. Although the first cost of the motor-generator set should be of secondary importance to the superior service provided by this method of control, reduced maintenance alone may be the deciding factor.

Even with a d.c. source of power supply, generator-voltage control with

a d.c.-d.c. motor-generator set is often used. It is true that d.c. motors with rheostatic control are capable of wide speed range and braking service; but for stability at all speeds, self protection against overloads, joltless starting, and superior braking, the motor-generator set with generator-voltage control is required.

Conversion of steam power directly to d.c. for fleet control of d.c. motors has received considerable attention were steam is also required for process work or drying. Such an installation eliminates considerable mechanical power transmission equipment, such as belting, shafting, and gearing, and provides a steady flow of low-pressure steam directly to the work where its B.t.u. content is made available. A turbine-driven paper machine unit utilizes such a cycle to drive the machine and heat the dryer rolls.

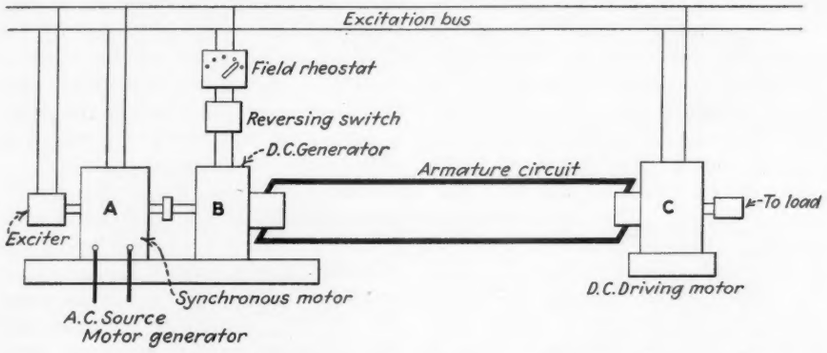
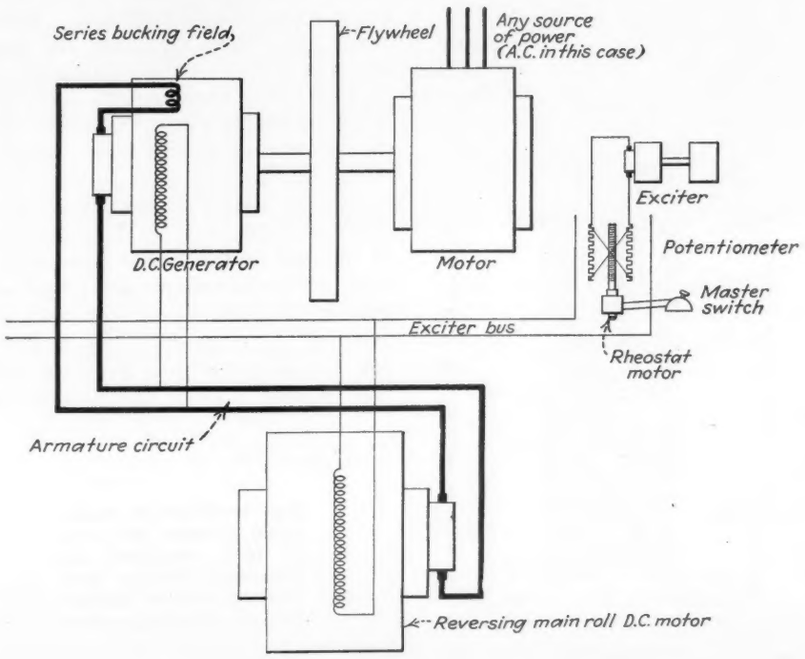


Fig. I—Simplified generator-voltage control connection diagram.



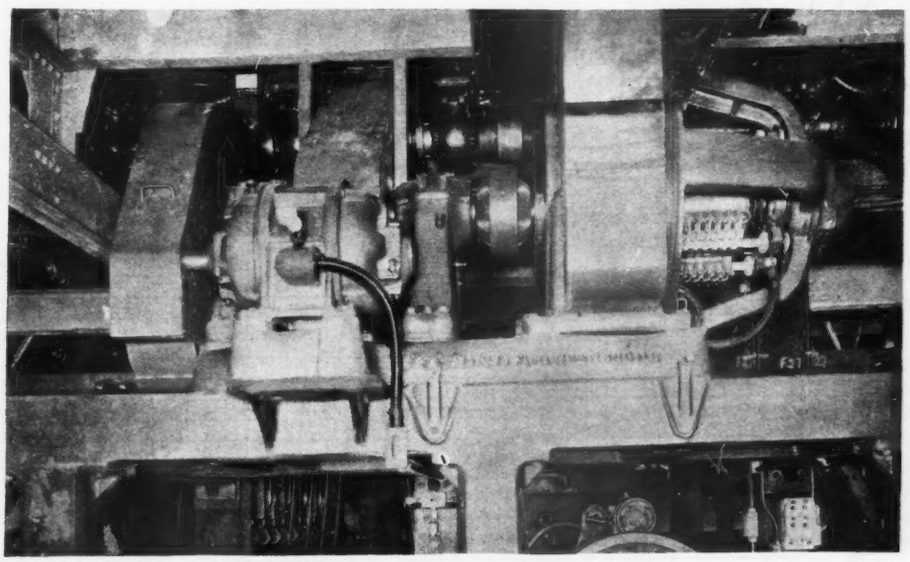
Several variations of generator-voltage control are used in the following applications:

1—Adjustable speed control for a single motor.
2—Adjustable speed control for a fleet of motors.
3—Overload protection without circuit breakers in the armature circuits.
4—Reduction of surges on the power line by fly-wheel motor-generator set and liquid-type slip regulator.
5—Regeneration and dynamic braking control.

Single motor control and some of its advantages have already been described in the introductory remarks. The size of the motor need not prove troublesome with generator-voltage control; the large motors driving the roughing rolls in steel mills are as readily controlled as the small winding motor on a paper machine and without making or breaking a heavy armature current.

Adjustable speed control of a fleet of motors has become quite common where it is desired to operate several motors from a master control. Grad-

Fig. 2—Connection diagram of essential elements for generator-voltage control of reversing main roll, steel mill motor with overload protection.



At the right is the main drive for one unit of the large newspaper press shown on page 63. Variable-voltage control provides a horsepower range of 200/15 with a maximum speed of 1,000 r.p.m. Synchronous motor generators provide the variable voltage by generator field control.

ual start from zero is readily accomplished for the entire group with the option of adjustment of the speed ratios of the individual motors by auxiliary control.

Overload protection, without breaking the heavy armature current in case of overload, utilizes generator-voltage control with the connections as shown for a steel mill main roll drive, in Fig. 2. In the event of an overload on the main roll motor, the differential series field in the generator circuit "bucks" the shunt field, reduces the voltage generated, slows down the mill motor, and relieves the load. The use of circuit breakers of large capacity to break the circuit is eliminated and maintenance costs and stoppage are reduced. Note the potentiometer rheostat, motor-actuated from the master control, which varies the excitation current from full-load requirements through zero to reverse without ever breaking the field circuit. The fly-wheel on the motor-generator shaft tends to smooth out power requirements from the line by supplying energy at the "peaks" and by absorbing energy while power requirements are below the average.

A fly-wheel on the motor-generator and a variable rheostat (slip regulator) provide an excellent method of limiting to a predetermined value power taken from the line by a fluctuating load. The smoothing-out action in connection with a d.c. hoist motor is illustrated in Fig. 3, where the slip regulator allows the set to take advantage of the pump back from the hoist motor to help store up energy in the flywheel. The extreme fluctuations of load to which the generator is subjected is supplied by the line at a very much lower and more uniform rate. The action of the wheel is illustrated by the speed curve of the motor-generator set. Whatever power is required by the hoist in excess of the chosen value is supplied by the energy given up by the flywheel as the speed of the wheel is reduced. During the periods of light power demand, the speed of the wheel is increased and energy is stored in anticipation of the next peak load.

The induction-motor on this motor-generator set is of the wound-rotor type with a slip regulator (liquid type rheostat) in series with the secondary winding. A motor having its primary windings connected in series with the induction motor (through series transformers) moves the electrodes in the slip regulator farther apart, thus introducing more resistance, more torque, and more slip when the load increases. When the induction motor current falls, resistance is removed from the rotor circuit, the motor slip decreases, and the flywheel absorbs energy again.

Another useful application of generator-voltage control is the regulation of the load on the synchronous motor that drives a magazine pulpwood grinder by controlling the rate of feeding the pulpwood. By examining the diagram in Fig. 4 an idea can be gained as to how this useful

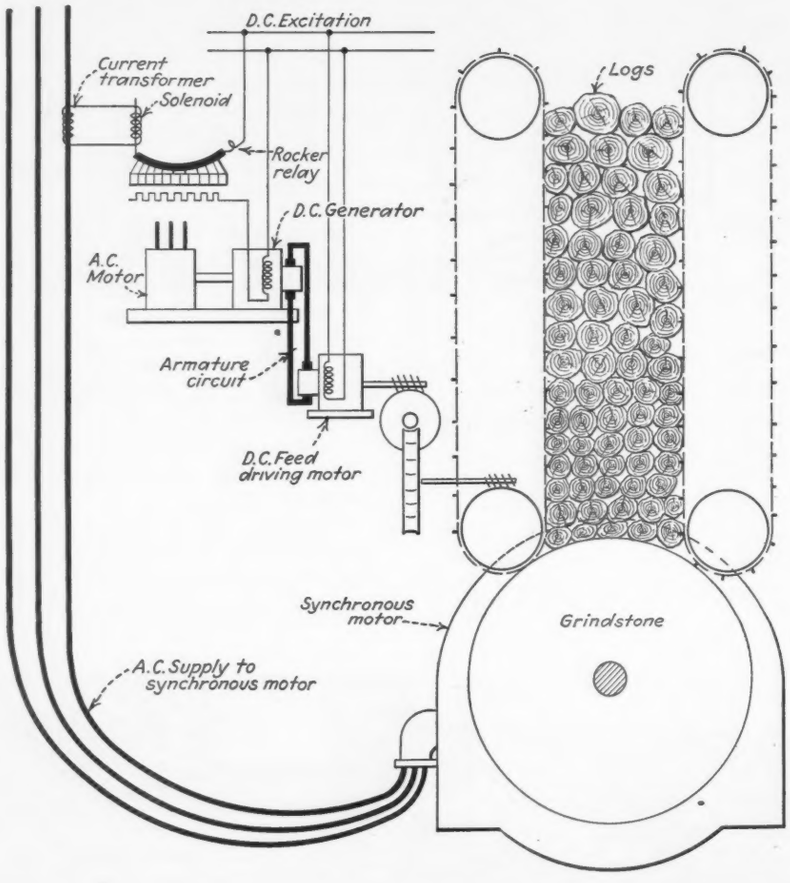


Fig. 4—Magazine pulpwood grinder has rate of feed regulated by generator-voltage control actuated by current input to grinding motor.

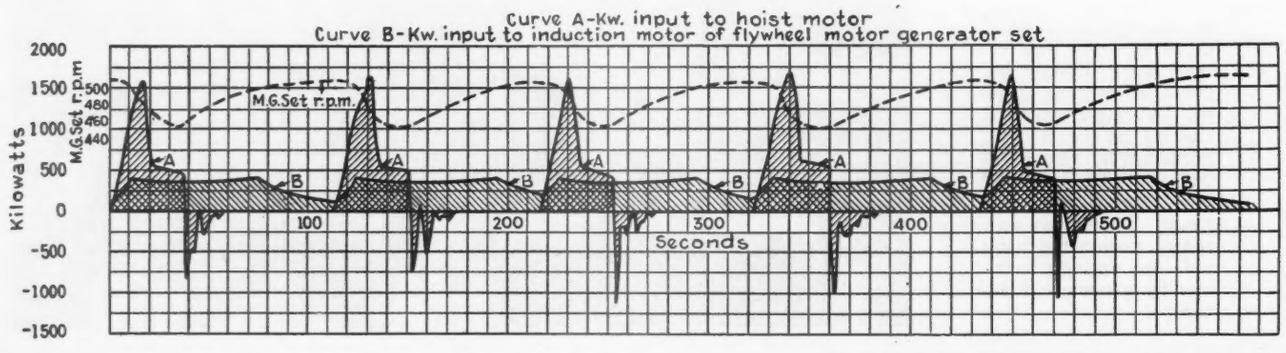
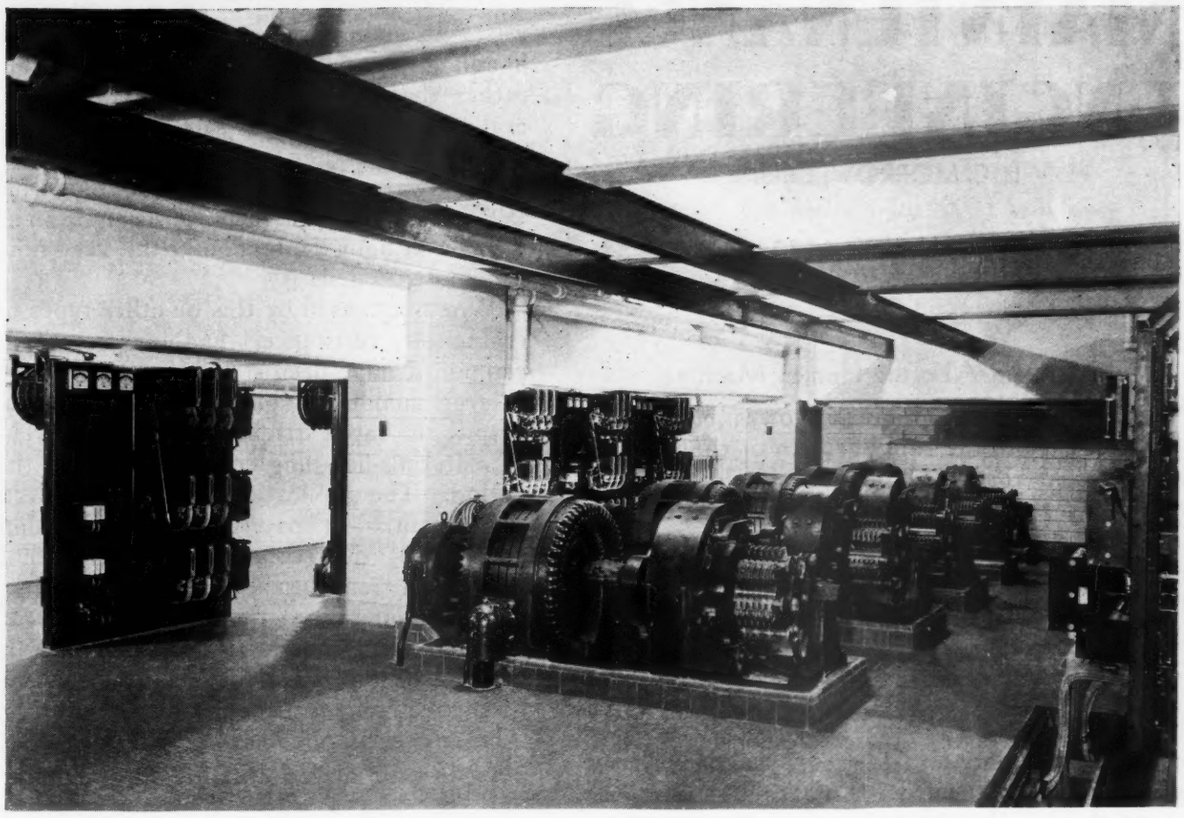


Fig. 3 — Load equalization by the use of a flywheel motor-generator set and slip regulator with generator-voltage control of a hoist motor.



Five 170-kw. synchronous motor-generators supplying d.c. to printing press unit drive motors on a large metropolitan daily newspaper. Generator-voltage control provides variable voltage for the main motor.

regulating operation is accomplished. The logs are carried down upon the periphery of the grindstone by motor-driven spiked chains, thus loading up the synchronous driving motor. If the logs group, applying a heavier load to the motor, the heavier current acting through the current transformer actuates the solenoid armature. A slight movement of the solenoid armature changes the position of the rocker relay and introduces more resistance into the field of the d.c. generator. As a consequence the generated armature-voltage becomes lower, the feed driving motor speed decreases, and the feed of logs to the grindstone is decreased, thus lowering the load on the synchronous driving motor to the predetermined value. This system holds the load on a 2,400-hp. motor within 1½ per cent.

A system permitting the control of a drill and hoist motor or mud pump motor by means of one or two generators utilizes generator-voltage control. The output from either or both generators can be diverted to either motor by closing a switch; rheostats in the fields can be manipulated to vary the excitation so that the armature voltage is under close control.

The advantage of generator-voltage control may be briefly summed up as follows:

1—Wide adjustable-speed range from zero to full speed.

2—Ready regenerative or dynamic braking.

3—Reversals without sudden torque applications.

4—Speed control and reversal by manipulation of comparatively small generator field current.

5—Inherent protection against overload.

Generator-voltage control requires a generator driven by a motor or other source of power in addition to the motor or fleet of motors on the load. In spite of this apparent handicap, its use is spreading throughout industry where the need of excellent control is recognized. The cost of the equipment and floor space required can in some cases be reduced by grouping a number of generators on a common base and shaft to one driving element.

Applications large and small, scattered throughout industry, include generator-voltage control of paper machinery, (winders and pulp grinders), dredge and shovel machinery, skip hoists, elevators (passenger and freight), printing presses, hoisting machinery, oil well equipment (drilling and pumping), car dumpers, sandpaper making machinery, steel mill equipment, lift bridges, and dynamometers. Some specific installations are described in the following paragraphs.

Paper Winders—The paper winder requires a wide range of speeds for satisfactory operation—slow speed for starting the roll and then gradual acceleration and deceleration for maximum winding efficiency. Generator-voltage control provides the delicate speed adjustment necessary and reduces the number of paper breaks.

Dynamometers—Direct current dynamometers are much used by manufacturers of engines, turbines, centrifugal pumps, fans, and blowers as a means of measuring power output or input. With a motor-generator set providing d.c. for excitation of a generator (engine or power output test) or for driving a motor (fan or power input test), generator-voltage control is quite convenient for speed control

(please turn to page 76)

MAINTENANCE ENGINEERING

L. C. MORROW, Editor

FEBRUARY, 1932

Maintain Also the Human Machine

BECAUSE modern industry owes much of its efficiency to the rapid growth of the machine it is logical that management should focus its efforts on the further development and maintenance of such a mechanical benefactor. But, in the early stages of this mechanical age, management became so entranced with its new tool that it concentrated on the machine at the expense of other contributors to economical production.

Fortunately, in these days, depression is driving home the fundamental that the efficient worker is at least as essential to low costs as the efficient machine. Management now realizes that the waste that can be charged to human error is exacting constantly a generous slice of net profit. Such error usually occurs when the human machine breaks down or is running at low efficiency because of inadequate maintenance.

How may the worker be made to operate at maximum efficiency? Granting other factors beyond our control, providing comfortable, healthful, and congenial working conditions certainly will take us a long way along the road to such an ideal. This part of the job can be laid fairly and squarely at the door of the maintenance engineer. He can call such a task well done when he has provided for all workers a heating system that distributes adequate, uniform heat; a ventilating system that circulates ample tempered air free from fumes; a lighting system that eliminates glare, shadows, and eye strain; safety features, both mechanical and supervisional, that reduce accident risk to a minimum; adequate washing, locker, and toilet facilities; and a plant that is painted to conform with modern standards of neatness and harmony.

■

Recommended: An Annual Materials-Handling Survey

DURING the past few years many executives, when approached on the subject of modernizing their materials-handling equipment, have deferred action with the excuse that they could "get along until business picks up."

Of course such an attitude will not stand analysis. It makes the assumption that materials-handling equipment is a dispensable auxiliary rather than an essential production tool. Generally conceded is the fact that low costs are essential to weather the present storm. But lower costs always follow equipment modernization. Why, then, postpone the acquisition of an effective weapon to fight depression at the very time when it is most needed?

Whether caused by this or other types of modernization resistance, handling methods and equipment have been stagnating for some time in a large number of plants. The situation exists despite the rapid strides made in the development of materials-handling equipment during the same period. The application of the photo-electric cell to the control of materials-handling equipment is but one of the recent developments that have broadened considerably the field of the equipment's adaptability.

What can be done to assure gaining full advantage of the latest cost-reducing developments of this equipment as soon as they are available? The answer is obvious: Conduct thorough surveys of your materials-handling at regular intervals, say once a year. Why not start the habit now? The prediction is ventured that, in most cases, the result of such check-ups will point the way to further economies, whether by way of the adoption of new methods and equipment or modification of the old. Recent developments may lick those problems that defied solution a few years ago.

■

Paint and Illumination

DURING the past decade a very effective concerted effort has been made by electric lamp and fixture manufacturers and by power companies to make plant engineers conscious of the value of proper plant illumination. The advantages to be gained by good lighting are now well known. The value of paint as an illumination tool has not, however, been fully appreciated.

Almost every maintenance engineer will admit that proper painting and proper lighting go hand in hand. But an investigation in many industrial plants has shown that quantitative knowledge of this function of painting exists practically not at all.

One reason is that illumination charges rarely are segregated. Lamp and fixture costs are generally known, but the current for lighting usually is charged to the total power costs. Obviously, if illumination costs as a whole are inaccessible, a definite idea of the part played by paint cannot be had.

Another reason is that many engineers do not

seem to realize that the level of illumination in their plants is as definitely mensurable as the water consumed or the coal burned per month. Yet their local power companies probably take foot-candle readings in industrial plants and render advice on illumination matters free of charge. It is always well to take such readings before and after any change in an illumination installation; it is only in this way that one can know whether he is getting his money's worth.

Definite values of the reflection coefficients of various colors of paints are available. By proper foot-candle measurements to obtain the reflective coefficients of existing surfaces, a fair knowledge of the increase in lighting to be expected by a painting program can be obtained.

In increasing illumination, interior painting should be considered as well as the installation of new fixtures or additional wattage for existing ones, for often a small amount spent in this direction gives the desired results.

If the size of the plant warrants, illumination costs should be closely controlled. This may be done by segregating the lighting current from the total power charges. The interest and depreciation on the original cost of the electric lighting installation (fixtures, wiring, transformers, and proportionate sub-station costs, and the like) should be included. Definite schedules for interior painting and cleaning of walls should be maintained. Standard foot-candle levels should be assigned to every department and periodically checked. It is only in this way that the most economical steps can be taken when a new lighting installation or an increase in existing illumination is called for.

■

Things We Want to Know About

A FEW DAYS ago one of our readers remarked: "If I want information on a given subject I can get it by 'phone. The chief value of your good publication is that it brings up many things which I did not know that I wanted to learn about." In that statement there is expressed a viewpoint that is of fundamental importance.

There are at least two standpoints from which we can view our jobs and the publications that we read. As seen from one standpoint, we may concern ourselves only with the problems that are of interest at the moment—cross our bridges when we come to them. Under the influence of this philosophy, the easy and natural thing to do is to look into a magazine or book only for those subjects that bear on the problems in hand, and to ignore everything else. Time and energy may be saved momentarily by so doing, but the inevitable result is practically certain to be a narrowing of interests and viewpoint that leads to stagnation and ultimate defeat of whatever ambition one may have had in the beginning.

Viewing our work and reading from the other standpoint we consider that any development or bit of information that affects our work even remotely is valuable, and regard it accordingly. Things move swiftly today. One important development crowds the heels of another. Ideas and practices that were adequate and successful a short while ago are being tested as never before, and rapidly replaced by something better. What were the dreams and visions and playthings in the research laboratories yesterday are practical, money-saving, indispensable realities in industry today. A new order and a new tempo of things present with dramatic suddenness problems that must be solved quickly. Success in any calling today involves the ability to look ahead and to be prepared on the basis of sound knowledge to take full advantage of every worthwhile development, quite as much as or more than mere facility to wiggle out somehow from under the problems that are continually descending.

The calling of maintenance engineer is comparatively new, its responsibilities great, its importance hardly realized. Serving many functions, its ramifications, which are numerous and widely varied, go into every important branch of engineering. The successful maintenance engineer has to be interested in and know something about a great many things, from management to some of the arts and many of the sciences.

Whoever aspires to real achievement in that work must search untiringly for the things he should be interested in and know about.

M. E. INDEX AVAILABLE

UPON request a copy of the index of the editorial contents of Maintenance Engineering for 1931 will be sent free to any subscriber. The index is arranged to show the articles under "subject" headings and contains cross references wherever they will be of assistance.

Although copies of the index will not be available until about March 1, we shall appreciate receiving requests as far in advance of that date as possible.

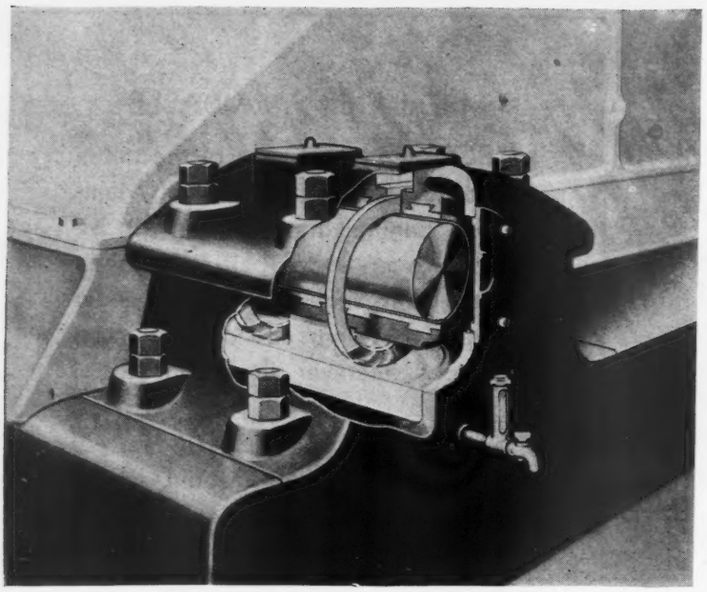


Fig. 72—Rings convey the lubricant from the reservoir to the shaft and bearing, from which it returns to the reservoir.

Photographs by courtesy of S. F. Bowser & Company

FRED H. LOW
Mechanical Engineer

LUBRICATING SYSTEMS

Recirculating Types

Eleventh article of a series. The next will appear in an early issue

IN THE systems known as "fresh oil," the lubricant performs two services—that of cleaning the bearing, and that of providing an anti-friction film between the rubbing members. When the oil, in addition, must convey heat from the parts, an entirely different system is required. Because large quantities must be handled, for economic reasons the oil is in some manner recirculated.

Of the several methods used to obtain the desired results, the simplest form is the one in which the parts themselves handle the lubricant. This form is termed the bath method and is used extensively on speed reduction appliances. The parts to be lubricated are inclosed in an oil or grease tight housing which is partly filled with lubricant. As the parts revolve they dip into and carry over some of the lubricant to those parts which are not submerged. The lubricant thus agitated conveys the heat from the working parts to the housing where it is dissipated to the atmosphere.

Next in simplicity is the system in which some simple device overlaps the shaft that imparts motion to it. Such bearings are termed ring, chain, or collar oiled according to the device used. Fig. 72 illustrates this method. The case of the bearing is cut away, exposing the reservoir, shaft, ring, and bearing.

The ring, which is considerably larger than the shaft, carries the oil from the reservoir at the bottom of the housing, depositing it on the shaft at or near the top. As the shaft continues to turn the oil spreads along the bearing and, after serving its purpose, returns to the reservoir.

Closely akin to the bath system is the splash method, in which the rapid motion of the parts is utilized in carrying the oil to the parts to be lubricated. This method is used in lubricating the cylinders of small internal combustion engines, particularly those used in automobiles.

A slight variation of the bath method is found in what is termed dip lubrication. The part to be lubricated, such as the wrist pin end of a connecting rod, dips into a reservoir or pocket of oil, the oil finding its way into the bearing around the ends or through a hole in the rod. Sometimes a scoop is provided on the moving part to insure a copious supply being provided. Where the part functions in the open, the extension or scoop also prevents accumulation of an excess of oil. This method sometimes is combined with the splash method in the lubrication of internal combustion engines.

Where an excessive amount of heat is to be carried off an excess of oil is supplied by means of a pump. The

oil may be either forced into the bearing under pressure or it may be applied by any of the other methods herein described. Often the method is applied to large gear reductions, the delivery being made through nozzles at the point of application. Outlets are provided to permit the oil to flow back to the reservoir or, as it is sometimes called, the rest tank.

Systems of this kind are employed on prime movers of both the steam and internal combustion types, and on machine tools and process equipment.

In some installations the oil flows by gravity to the points of application; in others it is delivered directly from the recirculating pump to the bearings. To illustrate the foregoing, Fig. 73 outlines a recirculating system installed on a paper mill. This system is complete, including the reclamation equipment, pumps, and storage tank.

From the reclamation tanks the oil is pumped into an elevated tank by one of the two pumps provided with the system. If, for any reason, the oil level drops below normal, the electric float switch starts the spare pump. When the normal level is restored the spare pump is cut out of service. The electric wiring is arranged so that either pump may be used as the circulating pump. Any surplus of oil in the gravity tank is returned to the clean oil compartment of the filter through an overflow pipe.

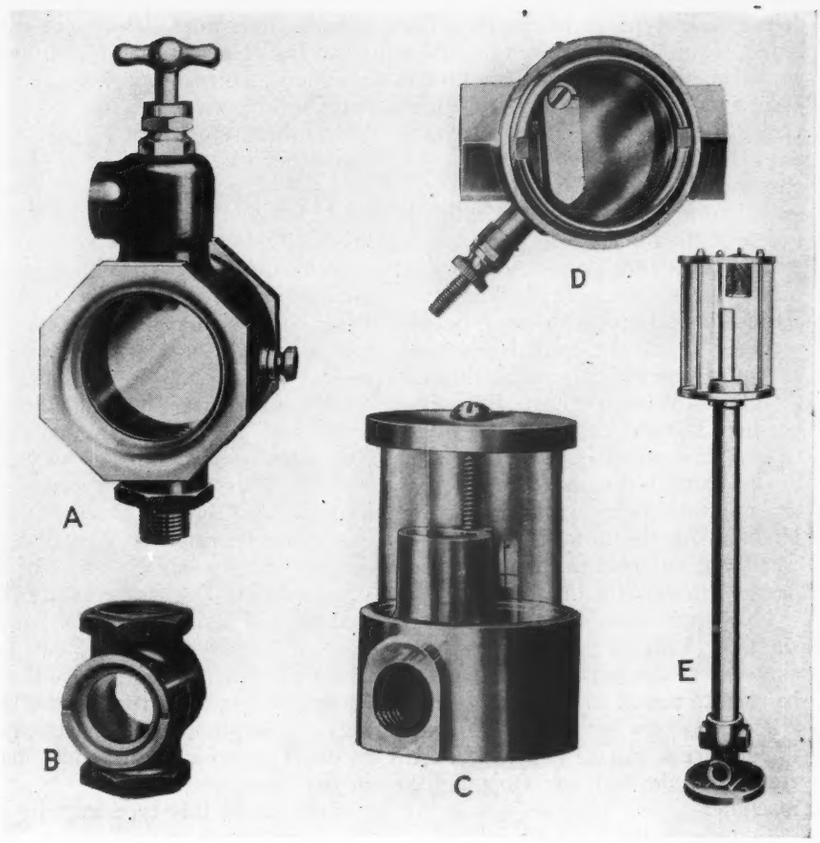


Fig. 74—Types of flow indicators developed for recirculation systems.

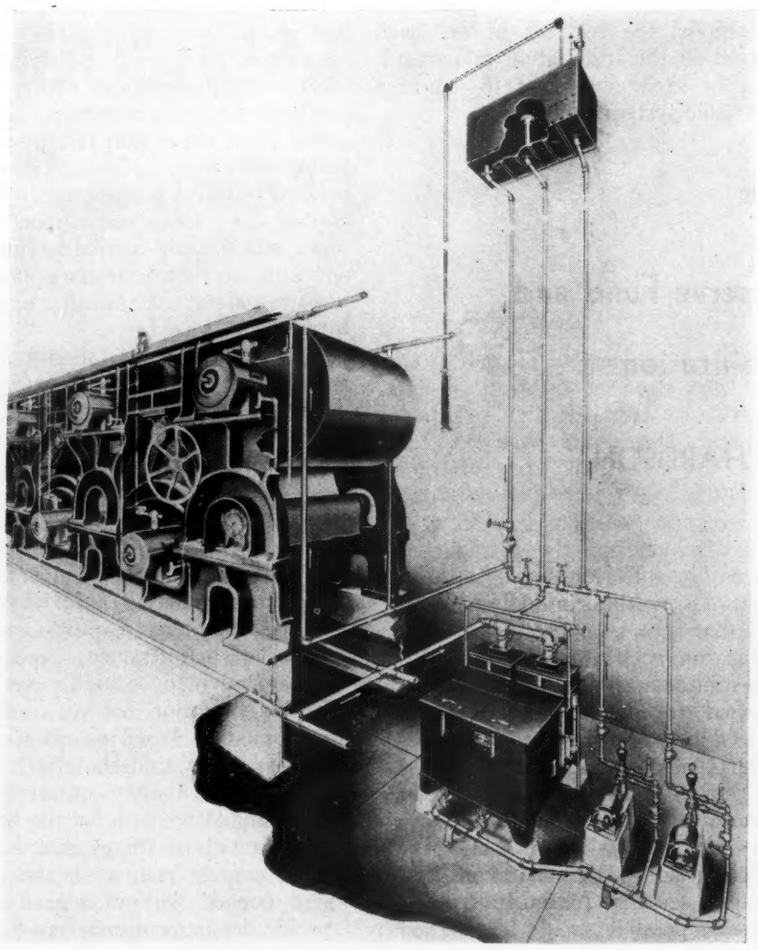


Fig. 73—Outline diagram of a recirculating lubrication system developed for one type of paper mill.

The storage indicator may be equipped with an electrical attachment, providing for the ringing of a gong or the flashing of a light in the event that the spare pump fails to raise the level in the gravity tank to the desired point.

Sight feed may be had by the installation of sight feed oilers and, where large volumes must be indicated, flow indicators, as shown in Fig. 74, should be installed. The type of indicator to be selected depends upon the volume of oil to be handled, the point of application, and whether or not the bearing is to be fed under pressure.

Indicators *A* and *B* are large size,

drip nozzle type sight feeds. The latter is of larger capacity, but it works on the same principle; the oil in passing through a nozzle is prevented from coming in contact with the glasses, permitting the flow to be observed. These oilers must be installed in a vertical position with the nozzle at the top.

By the use of a sight flow indicator of the type shown in *D* the flow of oil against a back pressure may be observed. Inside the body is hung an indicator vane which is visible through the glass. When the vane assumes a position at right angles to the direction of flow no oil is passing through the indicator, but when the oil is moving the vane takes a position in the direction of the flow, thus giving a rough indication of the quantity of oil passing through the line.

Flow indicators of this type are supplied with or without electrical contacts, as desired. This device can be used to sound an alarm or turn on a light. Where the oil line is of vital importance it can be made to actuate equipment devised for stopping the machine.

Sometimes the indicator is installed to advantage on the return line. An overflow type, shown in *C*, Fig. 74, can be installed at any convenient point in the return line or it may be installed so as to maintain and indicate the proper level in a ring oiled bearing or similiar application.

These indicators, which are made in several designs to meet different conditions, consist of glass inclosed standpipes from which the oil overflows to the return pipe.

Another use of this type is to indicate the action of the system as a whole by overflowing some of the oil. In this case the indicator may be located at a point where it is under constant observation. To make it more conspicuous a larger type of unit, mounted on a stand, as shown in *E*, Fig. 74, may be employed.

This unit consists of a double pipe stand and the glass inclosed head. The outer pipe is the delivery line, and the inner one, which extends up into the head, is the overflow. The line to the bearings is taken from the delivery fitting at the base of the stand. When the system is in operation oil will stand in the head to the level of the overflow pipe, but when the pumps cease operating the oil leaves the head and runs to the bearings. The pumps employed may be of any type which will handle the oil in the capacities desired.

Systems of this type may be purchased as a unit or they may be made up of items purchased from several sources. If the latter course is followed it will be well for the purchaser to employ the services of one well versed in the installation and operation of such equipment to insure a workable system.

■ ■

The Maintenance Reserve Fund and Industrial Stabilization

EDWARD A. RICHARDSON
Bethlehem, Pa.

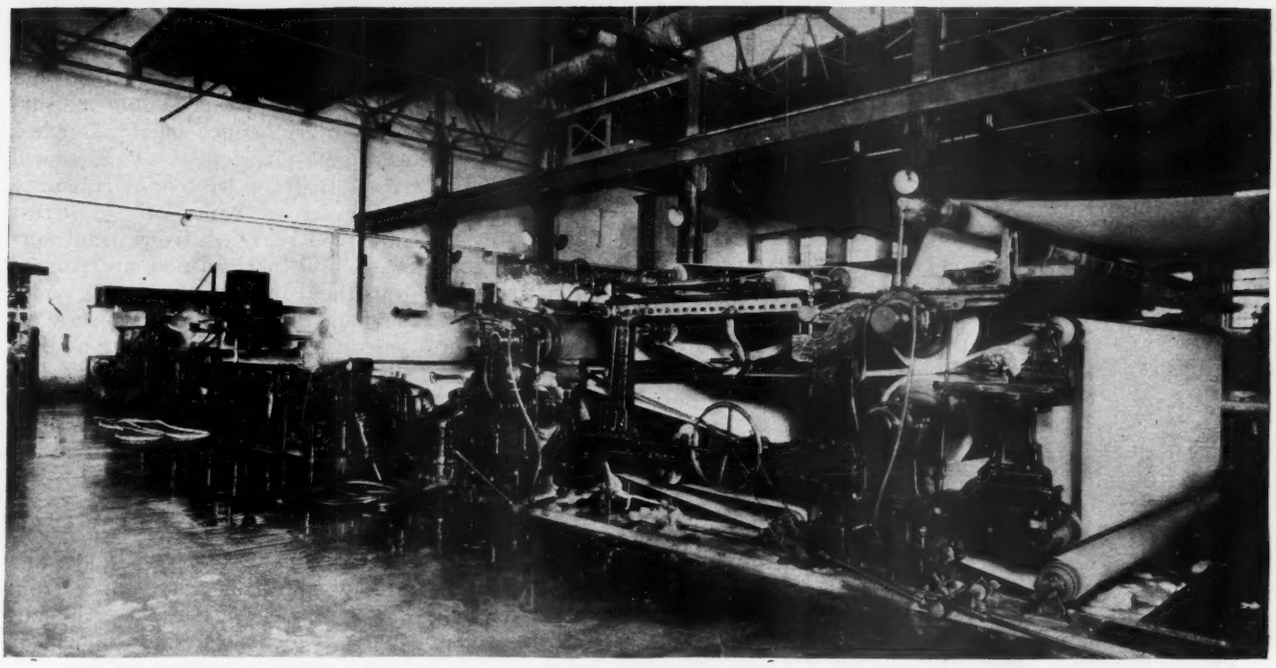
BECAUSE the question of a maintenance reserve fund is bound up closely with the problem of industrial stabilization I write from that standpoint. During boom times the tendency is to expand a business as rapidly as funds become available to meet the existing demand and to provide for anticipated requirements. This tendency leads to undue expansion of capacity and excessive capital charges when the recession, inevitable with such methods of carrying on business, takes place. It also leads to excessive suffering through the discharge of workers and all of the other ills that depressions bring on. In the long run such a tendency works to the disadvantage of every one concerned, for more wealth can be produced by a consistent effort than by spurts and periods of inactivity.

During boom times physical expansion of a plant should be discouraged as much as possible with due regard, of course, to the character of the market served. As much of the business as possible should be handled by use of incentive schemes, night shifts, and the like, so that the advantages of the full use of equipment are secured. In other words, a conservative policy of plant expansion should be the rule, although cost cutting by means of improved machinery and methods to increase the effectiveness of the available labor supply are permissible and should be encouraged if the saving can be reflected in a lower price of product and higher profits.

If a concern so managed is unable to earn a substantial surplus under such conditions of operation it is questionable whether it is justified in being in business. If it does earn such a surplus it is obvious, subject to the limitations I have imposed, that it cannot "plow back into the plant" the money so earned; therefore a substantial portion of the profits should be placed in reserve, and a conservative dividend and salary policy should be maintained. The reserve fund should be largely liquid. A certain loss of possible income probably will result from using this plan, but reserves not available when needed often are worse than none. Conditions during this depression have brought out forcibly the need of reserves especially liquid reserves.

During a depression, when business is slack, planning for the rise should be carried on; markets should be studied afresh; methods and machinery should receive attention; and the actual plant expansion felt justifiable under the sobering influence of depressed business conditions should be carried out. Once started such a reserve will contain available funds at any time, so that desirable opportunities for maintenance or other expenditures can be seized.

Reserves, however, should not be ear-marked for maintenance itself. They are effective only when maintained intact to be used in the business wherever and whenever they can be used most advantageously. Normally additions should be made to reserves in excess of regular depreciation and maintenance, and a portion of the reserve may be utilized reasonably for maintenance purposes when a special maintenance expenditure can be shown to be highly desirable. The authorization for such expenditures must be based on questions of business policy and the effect of cycles on the business in question. Decision should be made on the basis of doing first those things that will lead to the largest return on the investment needed without regard to the specific department concerned.



Only high-grade paint intelligently applied can survive the extreme moisture conditions of a paper mill.

PAINTING THE INDUSTRIAL BUILDING

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Chief Engineer
The H. K. Ferguson Company
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ALTHOUGH the major requirement of paint is preservation the importance of its decorative value should not be overlooked. The alert executive realizes that, by maintaining a bright and attractive plant, he secures lower production costs and realizes better prices for his finished goods because of better quality. The well-painted plant indicates good housekeeping, is conducive to better work, and has an important advertising power. In it errors and accidents are reduced and lighting expense is lowered.

The total cost of paint protection usually is less than 3 per cent of the entire cost of the building structure. When it is realized that nearly 70 per cent of the cost of painting represents the cost of the labor of application, one can appreciate readily that the difference in price between good and cheap paint is negligible when compared with the total expenditure. To try to save on the item of paint is invariably expensive. If the structure is painted with poor material the cost of application will be an unnecessarily large item over a period of years.

Paint failures usually can be traced to the use of improper materal, improper application, or application on surfaces which are not in proper condition. A paint of good quality may fail because it has been specified for the wrong location. Not only is the removal of faulty paint a costly item, but working conditions in a plant often make paint removal impracticable. Picture the difficulties of repainting the walls of a laundry or paper mill, constantly wet with condensation from process. Bearing in mind the fact that paint can be bought at almost any price, one can appreciate that it is advisable to place the responsibility for furnishing the right materials to meet the specific conditions with a reliable paint manufacturer.

The length of service of any paint depends to a great extent upon the way it is applied. Paints should be brushed over the surface with repeated strokes of the brush to insure adequate adhesion and penetration. This precaution is especially essential in the case of rough surfaces. When paint is simply flowed on, without additional brushing, it lies on top of any extraneous film that may be on the surface at the time. It bridges over irregularities in the surface without sufficient contact and forms a coat of varying depth. Too thick a

coat is likely to wrinkle, in which case wear is uneven and repainting difficult. Too thin a coat also is objectionable because only a slight amount of chalking is required to expose the surface to the weather.

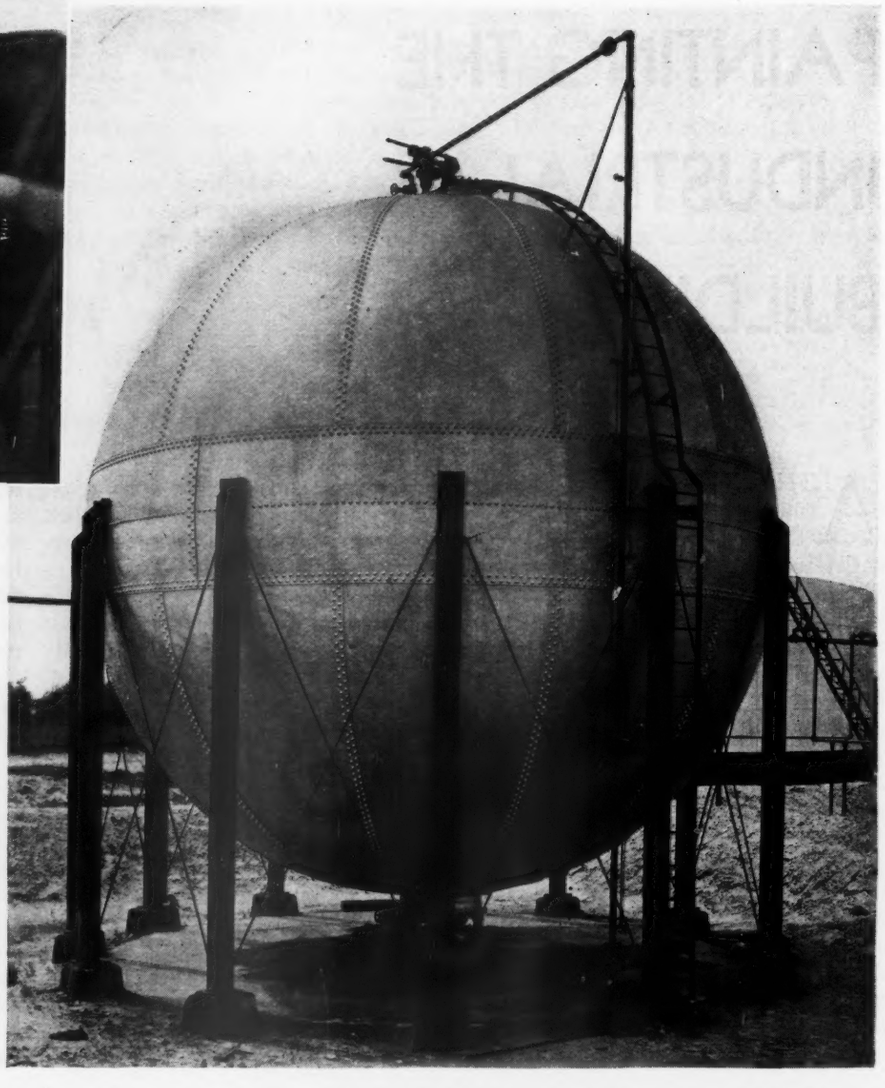
Spray painting requires a skilled operator to insure a satisfactory result. A proper balance of paint, air volume, air pressure, and distance of the nozzle from the surface is essential to good work. Too much paint applied by spray causes surface wrinkling. Too little air causes atomization of the liquid, and uneven coats result. Too low a pressure results in insufficient contact between surface and liquid; whereas too much air pressure drives the paint into a mist and results in an abnormal loss of material and a poor film of paint.

Although basic rules pertaining to surface and atmospheric conditions are generally known and are broadcast by every paint manufacturer, it is surprising how many engineers violate them. Dampness of the surface should be guarded against especially. If a wood surface is wet or even damp it will repel oil paint. An invisible film of moisture on the surface of metal tends to cause corrosion underneath the paint film and to prevent the paint from adhering to the metal. Moisture in brick or plaster walls at the time of painting will cause trouble almost invariably. Care must be taken to distinguish between superficial surface drying and the thorough drying that is essential to the proper performance of the paint.

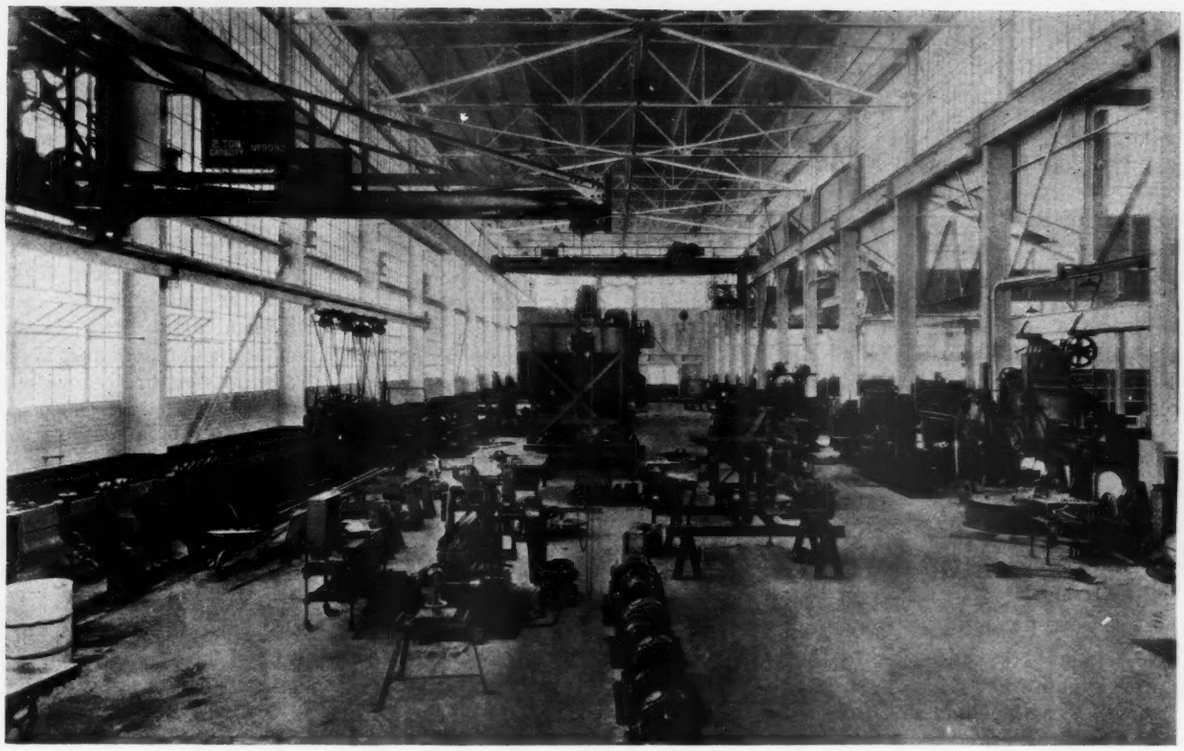
Mud, concrete, and mortar should be thoroughly cleaned from all surfaces to be painted. Paint applied over greasy or oily surfaces will never penetrate, harden, or adhere to the surfaces. Mill scale and rust should be removed from metal surfaces. When rust spots are painted over the corrosion continues under the paint and eventually pushes off the entire film. It is a waste of time and material to paint over loose or peeling paint. Priming coats should not be applied shortly after a rain or during excessively humid weather. Also, painting during cold or frosty weather should be avoided.

After accepting the reliable manufacturer's materials it is a good rule to apply the paint as it comes from the container. The unscrupulous painter is inclined to add thinners or dryers either to reduce the labor of brushing or to accelerate the drying.

Special care must be exercised in selecting and applying paint to outside steel work so that it will withstand the corrosive action of the elements. The steel shown must be repainted immediately to save it from disintegration.



Because aluminum paint keeps radiation losses to a minimum and is highly resistant to moisture it is an ideal protective covering for gas tanks and containers.



A well-painted interior is always reflected in the quality of the product.

Such ingredients are invariably in the paint before it is shipped from the factory. The addition of dryers in special cases may be justifiable and harmless, but an excessive amount of such material will shorten the life of the paint. One of the greatest enemies of paint is the use in it of an excessive amount of dryer.

The most common thinner used is turpentine. Because turpentine evaporates when drying a large percentage of it will cause the paint to chalk. Turpentine has a tendency to sweat weeks after the surface painted is dry. During sweating turpentine gives off an objectionable odor that is readily acquired by foods and, consequently, it should not be used to excess in bakeries or food warehouses. When added to paint linseed oil oxidizes and increases the elasticity of the paint film. An excess of turpentine or linseed oil will make a coat of paint so thin that it is easy to rub through the surface.

The first coat of paint on a steel surface is the most important. It is almost impossible to correct the results of a faulty shop coat. Paints for priming steel preferably should contain a substantial amount of basic or chromate pigments to retard corrosion. Although rust is by far the most common example of corrosion, much of the corrosion in the industrial plant may be attributed to the action of corrosive fumes and gases. Such fumes and gases are not confined to the chemical industry but find their way into the atmosphere from smoke stacks, furnaces, and other sources in practically all industries.

A mixture of red lead and oil is recommended strongly for the shop coat on steel. It makes a hard, dense, and elastic film that is impervious to moisture. Less costly, but with high protective properties, is iron oxide. The addition of about 10 per cent zinc chromate adds greatly to the rust-preventing properties of iron oxide, which otherwise is only slightly inhibitive. An interesting fact brought to light in the recent wrecking of the old Waldorf-Astoria Hotel in New York is that the only effect of time on the one coat of red oxide paint applied to the steel 40 yr. ago has been to dull the high gloss of the paint.

For the finish coat on steel there are three types of paints which are satisfactory for the purpose. In a textile or furniture factory, where cleanliness and light are especially important, mill white paints are used. Many owners have thought it necessary to start with a gray shop coat to get a satisfactory coverage of white in the final coat. Tests have proved that there is no advantage in a coverage of white paint over a gray base as compared to a red base. Two coats of white paint are required in either case. Where a final coat of gray is desired good coverage may be secured in one coat over red.

For the steel mill, the foundry, or the forge shop a black graphite paint is recommended for the finish coat. Because of its extreme resistance to moisture this pigment makes an excellent field coat over a rust-resisting first coat.

Because it is metallic aluminum paint has a rightful place on structural steel as an after-coating. Although high in reflecting value, the metallic aluminum flakes are entirely opaque and, therefore, protect the underlying paint from sunlight, which deteriorates many paints. The aluminum powder increases the water-resisting qualities of the paint film. The low heat loss by radiation from a bright aluminum coating is a real advantage in the case of gas containers.

For outside sheet-steel work subject to expansion and contraction with temperature changes linseed oil should be added to the paint to increase its elasticity.

Newly installed galvanized sheets will not take paint satisfactorily, but about six months' weathering will oxidize the surface of the zinc enough to permit satisfactory painting. If it is undesirable to wait so long a copper sulphate wash can be applied and, after the sheets are dry and the crys-

tals brushed off, the paint should be applied.

The major item of interior woodwork requiring painting in the industrial building is the ceiling. It usually consists of yellow pine lumber. The knots and streaks of pitch that usually are found in this lumber are likely to work their way through white paint unless sealed over.

The best paint for wood surfaces is a mixture of white lead and oil. Because yellow pine absorbs the oil very slowly, the priming coat should be mixed with sufficient turpentine to secure a thin consistency. A second coat, thicker in consistency than the primer, is sufficient for wood roof sheathing.

All brick walls and plaster surfaces to be painted should be completely dry; otherwise the moisture will bring active alkali to the surface with consequent blistering and peeling of the paint. Before painting the surface alkali should be neutralized with a zinc sulphate wash and, after it is dry, the crystals should be removed. The first coat should be a sizing coat with the addition of a small amount of paint pigment. This sealer prevents penetration and loss of oils from the final coats. Such penetration results in spots of low gloss that are "flat" in comparison with the remainder of the surface.

I realize that the painting of plants in which acid and fume conditions are extreme, or high humidity exists is a special problem. Here it is essential that the plant engineer consult a reliable paint manufacturer and insist upon seeing an existing application of a similar nature before selecting his paint.

■ ■

Maintenance of Transportation Equipment

C. B. STOUGHTON
Tapoco, N. C.

THE IMPORTANCE and value of a regular preventive maintenance program applied to plant equipment generally is recognized. But, in many plants in which a regular program of equipment inspection is carried out, inspection of automotive equipment has not been included. Owing to the common use of motor cars it has become a general habit to let them go until real trouble develops. Although we get along with this method to a certain extent, much trouble might be prevented and the life of the equipment increased by a regular program of inspection and maintenance.

Most plants are provided with means of transportation which represent an investment. This investment should be protected in the same manner as plant equipment is protected. When several persons use a motor vehicle, the usual result is that each individual leaves the responsibility for its care to another. Often, in consequence, such cars are low on oil, have under-inflated tires, or their batteries are dry.

Realizing the importance of its transportation equipment, one hydroelectric plant has instituted a monthly system for the inspection of this equipment corresponding to that used for the plant equipment. This plant is provided with power boats, automobiles, and trucks. It frequently happens that the same mechanic does not make successive inspections; therefore it is desirable to maintain a record of each inspection.

With this end in view an inspection form was prepared to serve two purposes: First, it acts as a guide and prevents the inspector from overlooking some important detail. Second, it serves as a record which may be filed for future use. The form must be filled out by the mechanic while he is on the job. In this way forms prepared from memory, which are of doubtful value at best, are eliminated. The monthly period for inspection has been selected arbitrarily. The regularity of certain jobs such as valve grinding are based on experience rather than on time. Regular inspection is supplemented by a weekly check of items such as tire inflation, battery, oil, and grease.

The value of the system has been proved by the results. Expensive repairs have been reduced to a minimum, and the equipment may be relied upon in an emergency.

MONTHLY INSPECTION REPORT

REPORT NO. _____ DATE _____
FOR: Service Car ____ Truck ____ Boat ____ Stat. Engine ____
TYPE: Car _____ Boat _____ LOCATION _____ MODEL _____
LICENSE NO. _____ SPEEDOMETER READING _____
OILED BY _____ INSPECTED BY _____

OK.	OIL & GREASE	USE	REMARKS
	Front Hub Caps	Grease	
	Steering Ball Joint	"	
	Spring Pivot Bolts	"	
	Front Axle Pins-R	"	
	Front Axle Pins-L	"	
	Steering Device	F.Grease	
	Handbrake Lever S.	Grease	
	Hand Lever Shaft	"	
	Foot Throttle Sht.	Eng.Oil	
	Clutch Trunnion Bear.	"	
	Transmission	Trans.Lub.	
	Differential	" "	
	Universal Joints	", "	
	R. Wheel Bearings	Grease	
	R. Axle Housing	Lub.	
	Ignition Instrument	Light Oil	
	Generator Bearing	" "	
	Bendix Drive	Eng.Oil	
	Water Pump	Grease	
	Prop. Shaft Bear.	Eng.Oil	
	Speedometer Shaft	" "	

TIRE PRESSURE RF ____ LF ____ RR ____ LR ____ SPARE _____

OK.	PART	REMARKS
	Clean Motor	
	Spark Plugs	
	Valves	
	Ignition System	
	Generator	
	Starter	
	Engine Base Oil	
	Compression	
	Carburetor Vacuum Tank	
	Gascolator	
	Horn	
	Steering Device	
	Lighting System	
	Fr.Wheel Bearing	
	Fr.Wheel Alignments	
	Fr.Axle Yoke Pins & Bush.	
	Rim Lug Nuts	
	Front Springs	
	Steering Connections	
	Rear Springs	
	Shock Absorbers	
	Rear Axle Shaft	
	Universal Joint	
	Body Bolts	
	Brakes	
	Clutch	
	Battery	
	Water Pump	
	Cooling System	
	Prop. & Shaft	
	Interior	
	Operating Tests	

GENERAL REMARKS:-

MAINTENANCE ORDER SYSTEMS

Part III—One Maintenance Requisition for Labor or Materials

G. I. ROSS

Chief Engineer, MacDonald Bros., Inc.
Boston, Mass.

IN DEVISING a maintenance routine for a small plant, innumerable schemes can, of course, be advanced. Many small plants use what might be termed a "Labor or Material" requisition for ordering maintenance work.

Under this scheme, any manufacturing department foreman may request maintenance work for his department. If the work is of a rush nature the request can be made orally, but a written confirmation must be prepared afterward.

The maintenance order, form A-1 (Fig. 2), is prepared in duplicate, and is signed by the foreman issuing it. The original is sent to the Maintenance Supervisor. The duplicate is retained by the man requesting the work.

Upon the completion of a job, the original of the form is handed for indorsement to the man who requested the work, and then is sent to the Cost Department.

Total job costs are not computed except where the work done is of a major character or of a plant betterment nature. In such cases form A-2 (Fig. 3) is used for the posting of labor and material costs.

Perhaps it would be well to point out here that the forms given in this and other articles of this series are not presented as impeccable standards; nor is the series itself intended as a treatise on form design. Indeed, some of the examples illustrated may not follow the best practice in form layout; but they are introduced to show how forms can be made an integral part of the maintenance routines described.

Next month we shall consider a slightly more elaborate system, designed for a plant of 500 employees manufacturing small metal parts.

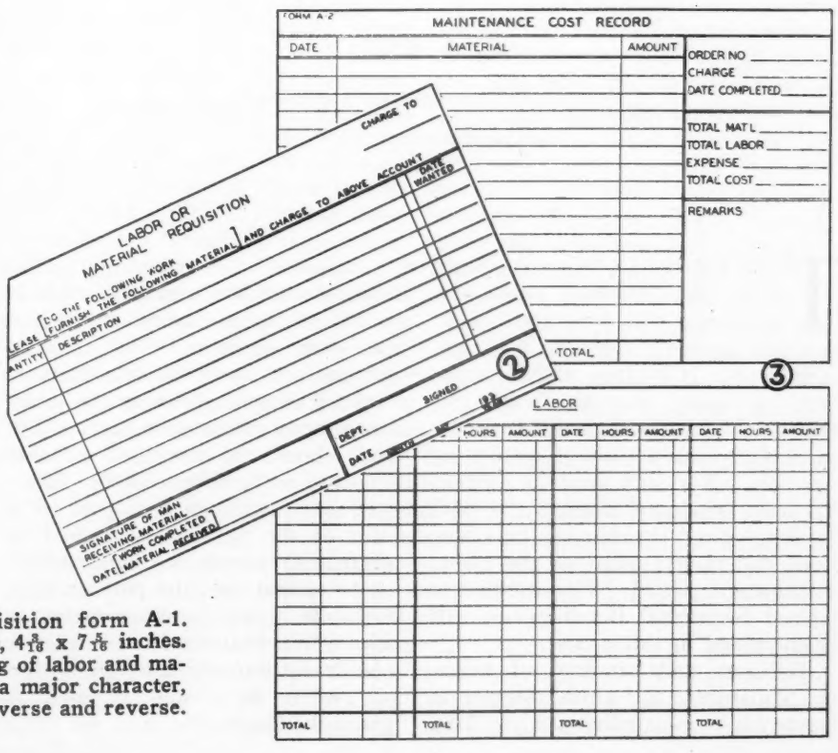


Fig. 2—"Labor or Material" requisition form A-1. Original and duplicate. Standard size, 4 3/16 x 7 1/16 inches. Fig. 3—Form A-2, used for the posting of labor and material costs for maintenance work of a major character, or of a plant-betterment nature. Obverse and reverse. Actual size, 8 x 5 inches.

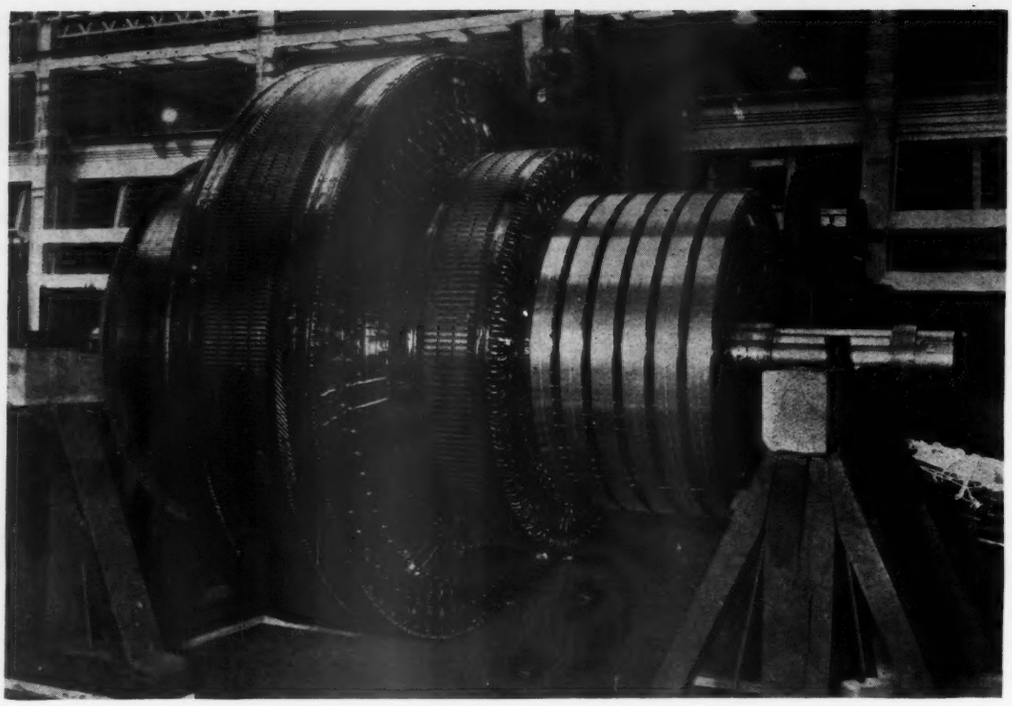


Fig. 1—There are two segmental bands on each end of both windings of this armature.

Segmental Bands and Banding Details

A. C. ROE

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THE PRECEDING article dealt with the methods used in preparing the core and windings and applying cold and hot running bands. It is often difficult, however, to apply running bands on armatures 90 in. in diameter or more, particularly when making repairs in the field. For such cases a method has been developed wherein the steel banding wire is made up into sections and then applied to the rotor, as shown in Fig. 1. This method is termed Segmental Banding and will be discussed in this article.

The core and windings of rotors or armatures to which segmental bands are to be applied are prepared as explained for running bands. Insulation under segmental bands consists of three layers of treated fullerboard segments. The strips or segments are placed so that there is at least $\frac{1}{4}$ in. space between the joints of each strip in the same layer. The joints should be arranged so that there are two thicknesses of fullerboard above each joint or gap. The width of the fullerboard should be sufficient to permit the band insulation to extend past the pins or keys. The wide joints between strips in each layer permit the band insulation to be drawn into a smaller circumference when the clamp is used to tighten the band.

The band insulation should be cut wide enough to support all the bands used on one end of the rotor, as shown in Fig. 1. When the surface of the fullerboard feels tacky, it should be treated with paraffine or powdered soapstone, just enough being used to remove the tacky feel. Before applying the band insulation the coil ends should be trued up and the space between coils filled. The insulation is held in place with two or three bands of $\frac{1}{8}$-in. diameter torpedo twine. These bands should be applied tightly to prevent shifting during application of the wire sections.

Segmental bands are made up of prepared sections such as shown in Fig. 2, which are wound on a steel form, clipped, and soldered. In preparing the sections the circumference of the end windings and band insulation must be calculated and this dimension divided into a number of standard and special-length sec-

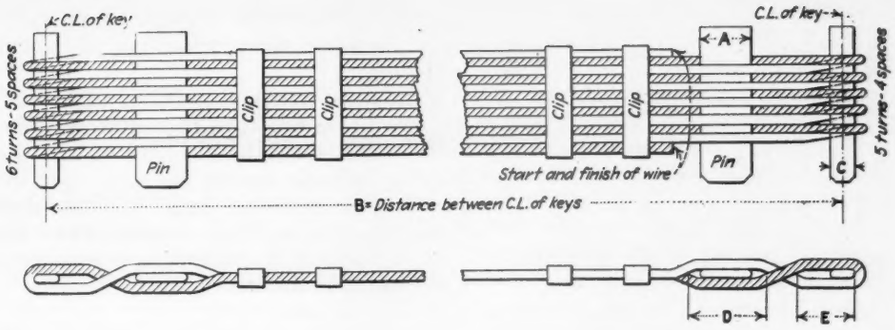
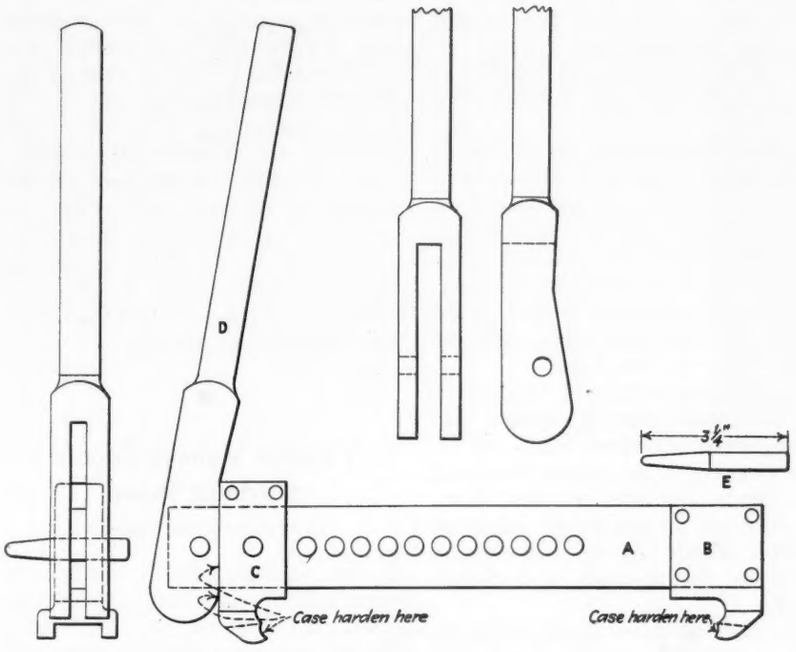


Fig. 2—How each section of a segmental band is made up.

Fig. 3—Details of tool for tightening and locking segmental bands.



tions, as will be explained later. The length of a section is equal to $B + C$, Fig. 2, where B is the distance between the center lines of the keys, C, and C is the width of the keys. The narrowest key, C, should always be used when calculating the length of sections, as the bands are tightened by using wider pins. Pins of different widths are used in making the sections in order to take up any variations in length.

Each standard and special section is made from steel banding wire, and there are twelve wires in each section. The wire is wound around pins at each end of the winding tool, making six turns at one end and five on the other, as shown in Fig. 2. While winding, the turns are spaced apart a distance equal to the wire diameter and then two openings are made, one at each end of the section, for the pins. Beyond the pins the wires are brought into a single layer, two steel clips are put around the bands close to the pins and soldered, and four other clips are equally spaced between the two sets of tie clips.

A study of Fig. 2 will show that the first turn is wound on top of the pin and under the key. The wire is continued around the key and passes under the pin. This order is continued until six turns have been applied. Note that around the keys the turns are spaced one wire apart, and between the pins and keys the wires are crossed from the lower to the upper planes. At the binding clips the wires are brought into a single layer.

When the sections have been wound and the proper pin used, the pins are soldered in place and the full length of the section is soldered, except for a short distance back of the keys, as the openings between the wires at the keys are made long enough to take a wide key. Keys are one of the means used to tighten segmental bands.

Sections of segmental bands are made in two lengths, measured as distance over the keys; a standard 5-ft. $\frac{5}{8}$-in. length, and a special length not less than 2 ft. $\frac{5}{8}$ in. long. When calculating the number of sections required for any segmental band, the circumference over the band insulation is determined and this dimension is divided into as many standard sections as possible; use a value of 5 ft. for length B when checking the number of sections. After dividing the circumference into standard sections, the remainder is made up as a special section. In some cases two special sections may be required, because sections must not be longer than 5 ft. nor shorter than 2 ft. Thus, if the remainder were 6 ft., two special 3-ft. sections would be used, or one 4-ft. and one 2-ft. section.

Sections are made in standard widths, which are twelve wires wide; if wider bands are required, two or more segmental bands are applied, as shown on the large armature in Fig. 1. When two or more bands are used the minimum distance between bands is $\frac{3}{8}$ in. and the insulation is cut wide enough to protect both bands. Tie clips are used to tie both bands together. When assembling the bands on the rotor, the keys of adjacent bands should be staggered.

When applying segmental bands the first step is to lay all the sections of one band out on the floor, interlock the ends of each section by putting the five-turn end into the six-turn end of the next section, and fasten all sections together with the special or $\frac{1}{2}$-in. wide key. This will leave two free ends. Next, measure the length of the total band and apply the band insulation so that the circumference over the insulation is from $1\frac{1}{2}$ in. to 2 in. longer than the assembled band.

A special pulling tool, such as shown in Fig. 3, is required for locking and tightening segmental bands. It consists of a long body, A, with holes drilled in one end, a fixed hook end, B, a sliding hook piece, C, a handle D, with an eccentric end as shown, and two pins, E. The hooks of ends B and C are case-hardened as indicated.

To lock the ends of the bands, hook the ends B and C over the pins on each end of the bands; then insert pin E through the hole in handle D,

and pull down on the handle, which will pull *B* toward *C*. If the key cannot be inserted in the ends of the band, put a pin *E* through end *C* to hold it in place, and move the handle up one or more holes; then remove the pin from *C* and take up more slack.

When pulling bands together tap the end windings down around the circumference. When two bands are applied to each end of an armature, put both bands on and fasten each by using a nail as a key; then tighten each band gradually until the ½-in. key can be inserted.

To tighten bands after locking the ends, try pulling each joint with the tool until the standard key can be inserted. Use the wide key to drive out the narrow key, to prevent the turns from springing apart. Repeat this operation all around until the band is tight. If the band is still not tight and wider keys are not available, the only recourse is to remove the bands, add more insulation and relock and retighten, as outlined previously.

Keys should be soldered after all bands have been tightened. Also, solder the anchor clips used to tie two bands together.

Temporary segmental bands can also be used to pull the lead end winding down, particularly when open - riser - neck commutators are used, so that the coil ends can be drawn down and held firmly in the commutator necks for soldering.

After an armature has been in in service for some time it is possible to pull up any looseness that may have developed by unsoldering one or more keys and using wider keys and the tool shown in Fig. 3 to pull up the slack.

The edges of all pins and keys should be well rounded, to prevent cutting the wire. Tinned-steel keys and pins must be used.

Replacing running bands with segmental bands requires that the space available be checked carefully for proper clearance, because the insulation, pins, and keys make the segmental band quite thick, which means that in order for the bands to clear the air gap the end windings must be kept low. Also, the clearance between any connections on the fields and the rotor surface must be checked.

Where it is possible to apply it, the running band is to be preferred to the segmental band.

In concluding this series of articles on the banding of rotors, a few general details will be added that are considered important enough to be given attention when rebanding any armature.

Fasten the start and finish of each band by using two clips spaced about 1 in. apart; then cut the wire after bending it back against the side of the clip, or hook the ends. Solder these two clips as soon as each final band is applied, in order to prevent loose bands if the wire breaks or the tension is released.

Establish the proper wire tension before applying the first turn of any temporary or final band.

Drift all adjacent turns together to form a tight, compact steel band or ring.

Solder the complete surface of all bands, using a non-acid flux, and be sure that the flux is not baked by holding the iron too long in one spot. The best results are obtained when the hot flux runs ahead of the iron; with a clean soldering copper at the proper heat the fluid solder will run freely with the hot flux.

Pure tin solder should be used on all crane, mill, mining, vehicle, and railway type armature bands, to insure freedom from solder throwing, loose bands, and other troubles. Also, use pure tin on armatures subjected to high speeds, or to temperatures above the normal class A insulation limits.

The pure tin flows freely and penetrates to all parts of the band, thus improving the adhesion.

All clips should be turned over on top of bands, and should extend over the band. Except on concave bands where there is a chance of the bands crumpling up, the clips should overlap a sufficient amount for both ends to meet.

It must be remembered that the banding structure extends through the coils and windings to the coil supports. Therefore, make sure when stripping any armature that all details are noted and recorded. If in doubt about any detail consult the manufacturer.

■

Air Conditioning Conference Announced

A CONFERENCE on air conditioning will be held at Case School of Applied Science, Cleveland, Ohio, March 17 to 19, inclusive. Some of the sessions will pertain to the conditioning of air for human comfort. The remainder will deal with industrial processes requiring controlled air conditions.

"Principles of Air Conditioning" will be one of five subjects discussed. The other four will be "The Unit Processes in Air Conditioning," "Features in the Design of Air Conditioning Systems," "Industrial Air Conditioning," and "Air Conditioning for Human Comfort."

Some of the details taken up under these five subjects will include air pollution and its relation to air conditioning, selection of heat transfer units for heating and cooling air, instruments and control devices applied to air conditioning, the relation of air conditioning to building construction, air conditioning requirements of specific industries, and the relation of outdoor and indoor air conditions to health and comfort.

Professor G. L. Tuve is general chairman. The meeting is sponsored jointly by Case School and the Cleveland Engineering Society.

■

Variable Voltage Control of Motor Speed

(*Continued from page 63*)

of the dynamometer. Automobile manufacturers not only study the power output of internal combustion engines, but make exacting tests with the dynamometer controlled in this way on individual characteristics of carburetors, lubrication, crank-case dilution, cooling systems, and the like.

Shovels—The smooth action of this control reduces the wear and tear on electric shovel machinery to a great extent. An electric shovel of moderate capacity (2 cu.yd.) has a 4-unit motor-generator supplying d.c. to the motors.

The shovel unit consists of a squirrel cage motor and d.c. generators of 50, 15, and 15 kw. for the hoist, swing, and crowd motors respectively. The motors are of the totally-inclosed type built for heavy duty. Speed change and reversal are accomplished by varying and reversing the fields of the respective generators. The same practice prevails for giant shovels taking a total of 2,000 horsepower.

Printing Presses—Publishers of metropolitan newspapers have recognized the value of a smooth application of power to their presses and have turned to generator-voltage control as an aid to speed production by "more haste with less waste."

BRUSHES WHICH

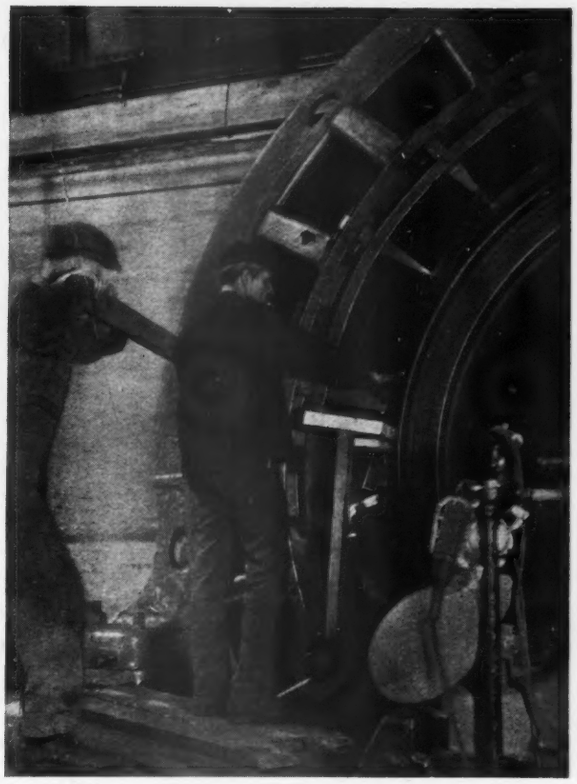
—operated well on one machine may fail utterly on another;

—were satisfactory on the manufacturer's test floor may function poorly in the field;

—suited a machine in the beginning may later have to be changed to keep pace with the characteristics of a machine which changes with age.

J. S. MARCUS

Sales Manager, Electro-Nite Carbon Company
Philadelphia, Pa.



Commutator and brush must be perfectly matched to insure satisfactory commutation—Polishing the commutator of a rolling mill motor.

Carbon Brushes

PART I

THE TERM "carbon brush" is a broad one. It covers a wide range of materials made of various mixtures of lampblack, coke breeze, natural grapite, artificial graphite, metal powder, and metal flake dust, combined with suitable binders.

Lampblack of proper purity and uniformity is obtained by collecting the soot resulting from the incomplete combustion of "dead oil" (a petroleum oil left after distillation). Some grades of coke powder come from the hard residue of oil refining processes, and others from the retort, by-process coking of coal. Natural graphite is mined. Artificial graphite is produced in electric furnaces by baking lampblack mixtures at high temperature.

The binders may be pitch, tar, molasses, or such hydrocarbons as will revert to pure carbon on baking. In certain special materials resin or bakelite has been used, while materials of very high copper content may have as aids in binding such low-melting metals as lead, tin, or zinc.

The usual method of manufacturing carbon brushes is as follows: The materials are milled to a fine flour (up to 300 mesh), the grain depending on the density finally required. The various proportions are mixed with the proper binder very thoroughly, often under steam heat, and the mass baked. This is then remilled to proper fineness, the flour mixed with further binder, and molded under hydraulic pressure into plates. The plates, protected from the atmosphere by a heavy covering of sand, coke tailings, and the like, are then packed in furnace ovens, and are baked for long periods at temperatures ranging to 1,800 deg. F., so that all volatiles are driven off. If the final material is to be artificial graphite, these baked plates are then packed in electric furnaces, the plates themselves forming the resistance elements. The various grades of "electro-graphitic" materials depend in part upon the completeness of this graphitizing and upon the temperature, which may run to 2,400 deg. F. One can appreciate the terrific heat of sparking when material processed at such high temperatures is burned under poor commutation.

After the heat-treatment the plates are ground to size and stocked, and blocks for brushes cut as required.

Classification

In general, the important factor in determining the field of operation of a brush is its basic composition. A

broad classification would be (1) copper leaf and copper gauze; (2) carbon-graphite (including high carbon, high graphite, and impregnated); (3) electro-graphite; (4) natural graphite (including flake and amorphous); and (5) metal-graphite.

Except on certain old types of very low voltage generators for electroplating, where drop losses must be kept to an irreducible minimum, pure metal brushes of either copper leaf or packed gauze are now obsolete because of their extreme cutting action and because of the large amount of care required to keep them in shape.

The lower grades of carbon-graphite, i.e., those low in graphite content, are necessarily of the lowest carrying capacity and of the highest abrasiveness. Therefore, they are limited to applications where mechanical strength is of major importance, as in contacts or repulsion-induction throwout mechanisms, and to low peripheral speeds where a decided cutting action is necessary, as in an oily atmosphere.

The higher grades of carbon-graphite mixtures, because of the high graphite content and increased carrying capacity, have a wide range of application since their characteristics can be greatly varied by formula and by processing. Although the friction of these materials is rather high, their relatively higher load values, combined with a high mechanical strength, lead to wide use on such heavy-duty equipment as cranes, trolley cars, and the like.

It is generally conceded that there is today no necessity for the old "self-lubricating" brush, which consisted of a hard carbon-graphite impregnated with oil or some other lubricant. Aside from the fact that modern brush manufacturers produce brush materials with low friction coefficients, there are many points to be taken against the old self-lubricating type. Sooner or later, depending upon heat conditions, the lubricant cooks out, causing gummy commutators, sticking brushes, and, in dirty condition, even short circuits. After the lubricant starts to leave the brush material, the characteristics change—contact drop varies, resistance is lower, and abrasiveness greatly increases.

The development of electro-graphite marked a decided forward step in brush manufacture. Here we have a high quality product, of consistently uniform composition fixed in advance, of high carrying capacity, with partially controllable contact drop and completely controllable abrasiveness and friction. One disadvantage of electro-graphites is a tendency to acquire a highly glazed face at slow speeds, which increases the contact drop and raises the friction to a point of chatter. Material soft enough to wear away faster than this glaze can form has short life and lacks uniformity. The major disadvantage of electro-graphite, however, is due to its non-abrasiveness and only moderate strength—unless it is very soft it cannot operate on flush mica. But since most modern equipment operates at speeds of 4,000 to 6,000 ft. per min., with current densities on the brushes of from 40 to 50 amp. per sq.in., and since at any rate the majority of maintenance men keep the mica undercut, this class of material enjoys the widest use by far, often comprising 90 per cent of a plant's total brush requirements.

In this article, the first of three, Mr. Marcus discusses the classification and physical and electrical characteristics of carbon brushes. Later instalments will deal with the theory of commutation, and will outline maintenance and inspection methods.

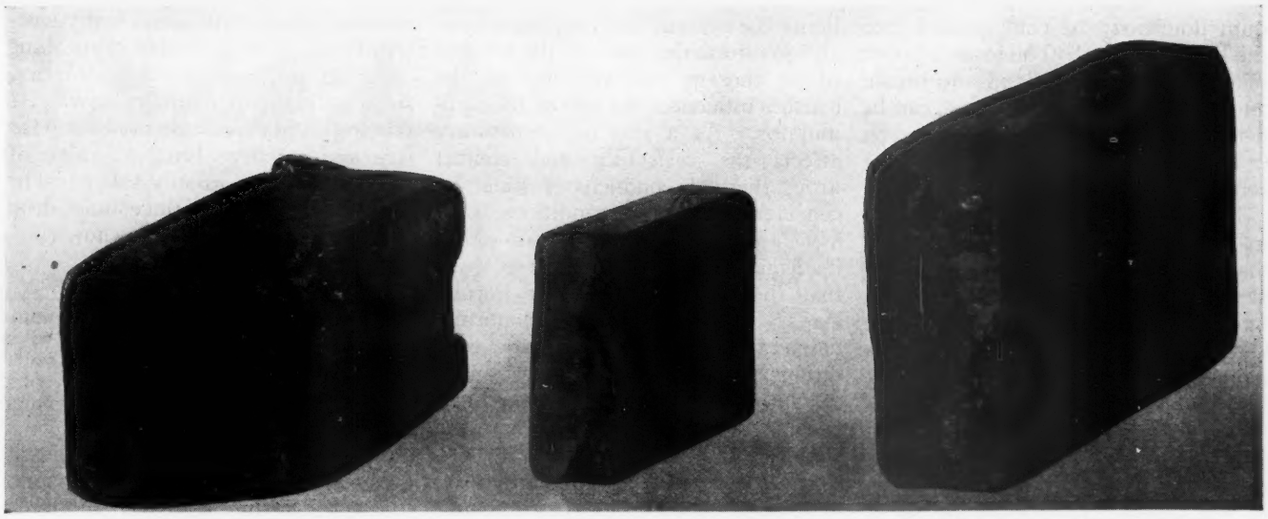
Graphite brushes are made from the purest mined graphite obtainable. The graphite is either in the form of fair sized flakes, or crushed to flake so fine as to be almost amorphous. The carrying capacity of graphite brushes is the highest, and its friction the lowest, of all materials not having a metal content. Because of the natural silica content of the mined material, graphite has an abrasive action, although in properly made compounds this is not excessive. Low density, giving low inertia combined with low friction, makes certain graphite materials ideal for use with high speed rings, as on turbo-generators and large synchronous condensers. The use of graphite on d.c. generators and on the d.c. end of rotary converters becomes advantageous at high peripheral speeds with comparatively low rotative speed, and on applications where loads surge beyond the limits of electro-graphite. Graphite, however, is mechanically weak as a rule, and has low thermal conductivity, so that while it withstands surges, the temperature rises on continuous overload. A modern use of graphite is that of holding down excessive armature currents by so constructing the brush that the resistance to these currents is high in comparison to that in the direction of the load current. This is accomplished by the use of large flakes, giving a striated structure, where advantage is taken of the flake-to-flake resistance plus the difference in internal resistance in the two directions through the semi-crystalline flake itself.

Metal-graphite materials are composed of various mixtures of copper flour (or extremely fine flake copper) and graphite, ranging from 50 to 95 per cent copper, with sometimes a slight amount of brass, lead, or tin. In these materials the internal resistance is much too low for it to aid in stabilizing commutation, as will be seen later. As the percentage of graphite increases, the contact drop rises and the carrying capacity drops, as does also the friction. These materials are manufactured for the purpose of securing a sufficiently hard brush that will not disintegrate from mechanical action or electrical load, i.e., one that will not "dust," and yet not be abrasive. The two major uses of metal-graphite brushes are on low-voltage generators where small drop and carrying capacity are of paramount importance to the output efficiency, and on sliprings where the current density is high.

Physical Characteristics

Hardness — This characteristic — which is often erroneously confused with abrasiveness to which it bears absolutely no relation—is simply the ability of a brush to withstand pressure. In carbon practice, the scleroscope is the accepted instrument for measurements, although there can be no really fixed values, because it is difficult to secure a series of truly uniform faces, as can be done with metal. The following table classifies in general the range of scleroscope readings in popular terms of hardness:

Scleroscope	Degree
0-15	Very Soft
16-30	Soft
31-45	Medium
46-60	Hard
61 and over	Very Hard



Just because brushes are inexpensive motor and generator accessories, their importance should not be overlooked. Here are three samples of carelessness in brush maintenance. Left — destruction caused by high mica in the commutator. Center—partial burning from excessive circulating current. Right—total burning from heavy overload.

Hardness is not a true criterion of actual mechanical strength, which can be judged only by transverse breaking stress—the load necessary to break the material loaded as a short beam. Carbon brushes may be many times harder than graphite brushes, but rarely more than twice as strong. However, a hard brush will usually be mechanically stronger than a soft one, and under vibration or similar strain will have a longer life, up to that limit of hardness which brings with it a high friction with a tendency to chatter, and a brittleness that will allow chipping under this chattering.

Friction—Friction is an important characteristic which is too little considered, probably because the progress made by brush manufacturers leads the user to feel that it has been completely taken care of for him. It is usually considered in terms of the coefficient of friction—the ratio between the unit drag of friction and the pressure perpendicular to the sliding surfaces—with values ranging under ordinary operating conditions from 0.05 to 0.3. No more than a relative rating—high, medium, low—for coefficient of brush friction can be given, because many variable factors enter in the case of a given machine, such as brush material, tension, condition of the commutator, speed, temperature, and the like. The normal limits between which the coefficients of friction of non-metallic brush materials lies are given in the accompanying table.

Pressure per Sq.In.	2 Lb.	4 Lb.	6 Lb.
High	0.15-0.30	0.25-0.45	0.40-0.70
Medium	0.10-0.20	0.15-0.30	0.25-0.50
Low	0.05-0.15	0.10-0.25	0.15-0.35

A low coefficient of friction is highly desirable, not only to obtain smooth action, but also to reduce the temperature rise, thereby lowering the energy losses which may reach surprising values on large commutators at high speeds. On these large commutators, the coefficient should be less than 0.2 if the friction loss is to be kept to a reasonable value. The standards of the A.I.E.E. for brush friction loss in watts per square inch of brush contact surface per 1,000 ft. per min. peripheral speed are 8 watts for carbon and graphite, and 5 watts for metal-graphite.

To calculate the friction loss, if

W = loss in watts,
P = total pressure on brush in pounds,
D = diameter of commutator in inches,
S = r.p.m.,
f = coefficient of friction,

$W = 0.0059\ P\ D\ S\ f$ per brush.

Although decreased spring pressure will reduce friction, there is a limit to profitable reduction, since full contact between the brush and commutator must be maintained. The type of brush holder used will affect friction, a box holder causing a higher coefficient than the reaction type unless both are set exactly at the theoretically correct angles, an extremely unlikely condition.

Contrary to popular belief, there is absolutely no relation between friction and abrasiveness. A very abrasive brush may have a much lower coefficient of friction and contact drop than a non-abrasive brush which gives a high polish and which may have high cohesion. A low-friction material such as electro-graphite is not as capable as carbon-graphite of withstanding the minute vibrations occasioned in a flush mica commutator. Therefore, a decided advantage of undercutting the mica lies in permitting the use of the better, lower-friction electro-graphite.

Oil may reduce existing friction, but its use is only a temporary expedient. It attacks the mica on flush commutators, and is actually dangerous on undercut commutators because the oil accumulates dirt in the slots and causes short circuits between the bars.

Abrasiveness—The ability of a brush material actually to wear away metal cannot be given in absolute figures because there is no unit of measure. Even the results of comparative tests can be applied only approximately to different machines or to different operating conditions, because degrees of abrasiveness are indicated only by the amount of surface wear of the commutator or rings.

Abrasiveness is due to impurities, usually iron and silica, in the raw material, and is lowest in electro-graphitic brushes made from artificial lampblack. Pure graphite brushes made from selected Ceylon flake will vary from a slight to a fairly high abrasiveness, depending upon the care in selection with regard to the silica that is always found in a natural mined product. To secure extreme abrasiveness, ash or even carborun-

dum flour may be compounded into the brush material. The exact amount of such foreign matter in any brush, and so an idea of abrasiveness, can be determined by burning out the carbon in a suitable furnace and weighing the remaining ash.

Metal-graphite brushes, properly manufactured so as to be free from disintegration at the face, have little abrasive action; but where such disintegration does take place, the abrasiveness may be quite pronounced.

Specific Gravity—With the exception of extremely high-speed machines, where centrifugal action must be considered, specific gravity is of importance only in manufacturing, where it serves as a check on final porosity and uniformity. Specific gravity for any given class of material will vary with the different methods of manufacture, but the following are some approximate values of weight:

	Lb. per Cu.In.
Carbon	0.06
Graphite	0.075
50 per cent metal-graphite	0.125
90 per cent metal-graphite	0.250

For longer life, greater uniformity, and lessened moisture absorption, modern brush practice favors a low porosity.

Electrical Characteristics

Specific Resistance—The specific resistance of a brush material varies of course with the material and process of manufacture, and ranges from 0.001 ohm per cu.in. for low-grade carbon to 0.000005 ohm per cu.in. for extreme metal content. Except on low-voltage equipment (6-12 volts) the specific resistance is negligible compared to contact drop, and in some cases even to shunt connection loss; but it will have an effect on temperature rise if it is too high. In special cases where high resistance may be of advantage in cutting down high armature short-circuit currents and commutator eddy currents, a special internal structure of the material may be used which will serve without heat or power loss. If an exceptionally high contact drop is required, high resistance cannot be avoided.

Thermal Conductivity—The thermal conductivity of a brush material is of importance primarily to the designer of an electrical machine, because it is this characteristic which limits the current carrying capacity—and so affects the size—of the brushes to be chosen; and the size of the brushes influences the size of the commutator. As a rise in temperature affects the resistance and contact drop, thermal conductivity must be considered wherever conditions, such as heavy overloads on machines or the inadequacy of commutators so worn that they are too light for normal loads, tend to increase the normal temperature rise. Under these conditions, if rapid heat dissipation is not procured, the commutator may become sufficiently hot to melt the solder of the coil connections, and so to cause open circuits in the armature.

Experiments in the Westinghouse laboratories on heat flow (which allowed for the contact film in addition to the thermal conductivity of the material itself) gave approximately the following comparative results:

Air	1
Half-baked coke brush	1.5
Bakelite bonded brush	2.5
Iron	2.7
Lampblack brush	3.8
Natural graphite brush	4.2
Copper	4.5
Graphitized brush	5.3

Carrying Capacity—The amperes per square inch of cross-sectional area that a brush can carry, under normal conditions, without mechanical or electrical breakdown, is termed its carrying capacity. For practical purposes, the values used are those limits set by a non-destructive temperature rise; and so carrying capacity bears a direct relationship to thermal conductivity. In rating material, a temperature rise of 50 deg. C. is considered as maximum, due allowance to be made for special service conditions. In general, a two-hour overload of 25 per cent or a one-hour overload of 50 per cent may be safely carried. Sliprings, or intermittent service, permit an overload rating up to 50 per cent.

In calculating the current density in the brushes of rotary converters, it should be remembered that the load per ring for machines of various phases will be approximately:

Single phase	1½ **d.c. output**
Two phase	¾ **d.c. output**
Three phase	1 **d.c. output**
Six phase	½ **d.c. output**

Contact Drop—The voltage drop between the brush and commutator is the result of contact resistance. It is this resistance which enables carbon brushes to function where metal brushes would fail.

Because the contact drop is variable, affected by almost every mechanical consideration and many electrical ones, it is preferable in speaking of it to use merely relative terms, such as high, medium, or low. As the drop is not the same for both positive and negative brushes, value of both together is usually taken. The limits between which the contact drop may be expected to lie are shown:

Total Contact Drop	
Very High	**2.2 to 3.0 volts**
High	**1.8 to 2.2 volts**
Medium	**1.2 to 1.8 volts**
Low	**0.5 to 1.2 volts**
Very Low	**0.2 to 0.5 volts**

For determining brush contact losses in carbon and graphite brushes, the A.I.E.E. has assumed standards for the total drop (positive and negative brushes) of 2 volts for brushes with shunts, and 3 volts for brushes without shunts, operating on commutators. In the case of sliprings the standard drops are assumed constant per ring for all loads as follows:

(*a*) Carbon and graphite brushes with shunts ..... 1 volt
(*b*) Carbon and graphite brushes without shunts ..... 1½ volt
(*c*) Metal-graphite brushes .. ¼ volt

As contact resistance is inversely proportional to current density, the contact drop changes but slightly with variations in load and may be considered constant within the range of normal operation. With increased pressure the contact drop decreases to a certain minimum. On slipring machines the current distribution is uniform over the face of each brush, and consequently the drop is the same at all points; but for commutator brushes the drop varies across the face in the direction of rotation according to the machine characteristics.

Although specific resistance plays its part in commutation, contact drop has a far greater influence. A brush of, say, 0.0015 ohm resistance at 50 amperes will have a voltage drop within itself of approximately 0.03 volts, whereas the contact drop will be 1½ to 2 volts.

As a broad general rule it is well to favor a high contact drop on non-interpole, variable load machines, to avoid as far as possible poor commutation because of the high commutation curents. On interpole machines of excellent characteristics and constant load, a smaller drop may be used. On low voltage equipment, the drop must necessarily be at a minimum and the design of the machine itself must take care of commutation currents.

PLANT ENGINEERS' FORUM

A new question is presented each month, and our readers' answers to previous questions are published. Write down your opinions and send them to the editor. Answers published will be paid for

Should Maintenance Methods Be Given Publicity?

George Shipman and Frank Fulleger have spent a week together attending a management and maintenance convention in a distance city and, in this scene, are speeding homeward in the club car of the railroad train. As we break in on the conversation, they are discussing the benefits of the trip.

* * *

"Well, Frank, do you think it was worth the time and expense?"

"Sure do, George. Got so many ideas that I can't wait to get back to work them out. Certainly is no depression in the development of maintenance methods and equipment. But, on the other hand, we have a few of the so-called modern maintenance methods licked right in our own plant, and I know that a few of our equipment stunts would make them sit up and take notice."

"Speaks well for your plant, George, in one way. But, in another way, I don't know."

"Don't get you, George."

"Why didn't they know about your better methods at the convention, Frank? Didn't you spread the good tidings?"

"Couldn't do it, George. Iron-clad rule in our plant. No pictures are allowed to be taken; no articles can be published; and visitors are kept away from such methods and equipment. We worked hard to develop them. Why should we give them away?"

"Lots of good arguments on both sides, Frank. How many ideas would you be bringing home from the convention if all plants kept their methods secret? And aren't the good will and recognition that follow publication of better methods worth something? Why not study the disadvantages of such publicity? You might find them considerably exaggerated."

"Again you've given me food for thought, George. It's way past my bed time, so I guess I'll turn in and sleep on it."

* * *

In spite of the fact that George and Frank seemed to be going around in circles in the preceding discussion, we can be sure that, as a result, doubt has arisen in Frank's mind as to the soundness of his company's publicity policy. Here is a problem for our readers that should prove to be healthful mental exercise.

Does a company benefit more to keep maintenance methods and plant equipment secret or to give them publicity?

What types of methods or equipment justify publicity or secrecy?

(Answers to previous questions start on the following page)

Readers' Answers to Previous Questions

How Valuable Are Professional Plant Surveys?

(Question presented in the January issue)

PROFESSIONAL plant surveys should be valuable to any firm. The qualified outside man sees many opportunities for improvements and reducing costs, which the engineers in the plant have skipped over simply because the opportunities are so evident that they have become commonplace. We have all seen the man with a pencil in his hand looking for a pencil. It's all in the outside point of view.

In the average shop, almost any visiting engineer can point out engineering defects that pass right over the head of the man who is in charge because the faults are "too close to home."

The outside viewpoint will aid a manufacturer to see many things in a different light and may expose serious errors in engineering which previously were considered negligible.

PHILIP DEL VECCHIO
Sipp Eastwood Corporation
Paterson, N. J.

IF GEORGE had finished his sentence he likely would have said: "Why the best of us do not know it all." And that is just the reason why a survey by an outside engineer can be of inestimable value, provided he is the right man with the proper qualifications. We often are so thoroughly familiar with our plants, their equipment, methods, and processes, and have become so accustomed to them that we have lost that suspicious attitude which finds expression in the mental challenge: Are things as they ought to be? Few of us, let us frankly confess it, can escape the dictum that we are more or less creatures of habit and tradition. We do get into a rut and need someone to jerk us out.

I have gone into plants and often have been surprised at the number of manual operations performed on work for which some mechanical device could be made with but little ingenuity or expense. And how the parties concerned expressed their surprise that they had overlooked something that seemed so obvious to an outsider!

The outside engineer is not handicapped by the habits and traditions of your plant. He has not looked upon the selfsame things so long that his vision has become blurred and indistinct. And, if he is a keen observer, is favored with a good analytical mind, is backed by years of practical experience, and possesses sound judgment and a lot of common sense, he will make you sit up and take notice.

Frank did not enjoy the lubrication engineers' survey, but he will be a wiser man by the time they are finished. A long time ago we had lubrication trouble in a food product manufacturing plant. Grease and oil were getting into the food products. Batches were spoiled. Customer complaints started to come in. I was called on the carpet. Something had to be done about it—and at once! Upshot—a lubrication engineer was called in. Results: 98 per cent improvement. And, while the engineer made his survey, I began to realize that what I did not know about lubrication would fill a big book.

At another plant we believed we had a pretty efficient organization. We had; even the outside engineer admitted it. But the management had a suspicion that things could be improved. So an expert was called in "to show us up" as the gossip in the plant had it. He did show us up but in such a way that not a single one of us took offense. We all profited greatly by what we learned, and the stockholders felt that the money had been well spent. However, he was not the professional parasite, the charlatan, or the quack, but an honest-to-goodness engineer who knew his stuff.

A recent experience was trouble with boilers foaming and priming. Repeatedly there were reports of boiler failures caused by embrittlement due to zeolite softened water. The outside engineer of a reliable chemical firm was called in. Results: We again breathe freely and dare to stay a few minutes in the boiler room without fear of being blown to bits. Incidentally we have saved a little money. We were blowing down too often. It's a shame to send good B.t.u.'s down the sewer these days. Our compound dosage was too large because we used too much softened water for makeup. A slight change in the formula for our boiler compound relieved us of the spectre of embrittlement.

Are professional plant surveys profitable? They certainly are, provided that the engineer is of the right type who is able to get 100 per cent cooperation from the management and the rank and file. But beware of the faker.

G. B. VAN HEYNINGEN, *Mechanical Superintendent*
National Tea Company, Chicago, Ill.

PLANT surveys by professional, lubricating, industrial, wage-payment, heating, or electrical engineers are profitable only to companies that have not kept abreast of the times. The average company today, however, is paying engineers of its own to handle such problems. Is it feasible, therefore, for a company to call in outside engineers to do jobs that its own engineers are hired to do and should be capable of doing?

In the case of mechanical, electrical, heating, and ventilating problems most chief, maintenance, and plant engineers are technically trained men who are fully capable of handling such problems. The sales engineers of the companies handling equipment are a ready source of assistance in the selection of replacements or new installations. Most of these men are mechanical engineers, and each one is a specialist in his specific line of equipment. Outside engineers usually are useful only to check a company's own engineers when it is felt necessary. At such times a survey may or may not be profitable, depending on the progressiveness of the company's engineers.

A company's management may be the cause of the backwardness of its engineer if it curtails his actions.

This situation is not likely to occur where the engineer can sell his ideas to the management and give a guarantee of the return on the investment. The average management is only too glad to have its engineers make improvements wherever a safe return can be assured.

PERCY E. GORDON, *Chief Engineer*
Carew Manufacturing Company
South Hadley Falls, Mass.

WHERE a specific problem is being dealt with a plant survey made by outside engineers is often profitable under certain conditions.

Most commercial establishments, such as those dealing in lubrication, illumination, belting, and the like, have men in the field for this purpose. Where the surveys are too general for example, where they take in a whole plant, their purpose is often defeated. Experience has shown that in surveys of the latter type it is really difficult to get an unbiased result, in that the one making such an inspection too often places the sale of his company's product ahead of the real purpose of his mission. I have seen surveys of the same plant made by competing engineers, many of them made with little study or knowledge of the peculiar requirements of the equipment involved, the results of which were so contradictory that they were amusing. Similar experiences have been encountered in surveys made on commodity requirements such as steel, belting, and the like, in which low price alone seemed to be the main objective of the surveyors rather than service and quality.

Surveys and recommendations of greatest value to those receiving them are those made by professional or consulting engineers, or specialists not directly connected with any commercial establishment dealing in the commodity or equipment involved in each survey and, who, therefore, are not likely to profit financially by their recommendations.

H. L. SCHULTZ
Assistant Superintendent of Maintenance
The Carborundum Company
Niagara Falls, N. Y.

PROFESSIONAL plant surveys should be divided into two general classes: those offered gratis by various manufacturers of supplies and equipment, and those for which a regular fee is charged.

When considering the installation of certain special process equipment our company often has called in engineers of outside firms and profited by the advice that they were able to give as a result of their specialized knowledge of the work in question. Our company also has seen fit at various times to call in industrial engineers, efficiency experts, time study men, and others who have made plant surveys and were able to effect some worthwhile economies.

In every one of these cases a fee was paid for the services furnished and, in most cases, the money was well spent.

I believe, however, that the so-called "free" surveys that certain manufacturers continually are trying to force upon us are an entirely different matter because practically all of them are just a form of high-pressure salesmanship. I have never seen a single one of them effect the economies that the manufacturer claimed. The results of most of these surveys are delivered to the prospect in an elaborate folder and consist of page upon page of data recommending the use of certain brands of material that only the maker of the survey can supply. If a plant had no engineering force whatever the information supplied by the professional plant surveyors might be better than nothing, but I can conceive of no other circumstance under which the data supplied gratis by these so-called experts can be of any value. I have kept a memorandum of the various firms that insist on providing plant surveys gratis and, in every case, I have found that they charge more for their product than do their competitors that do not offer this additional service. It is only reasonable to suppose, of course, that the customer pays the bill for the survey.

In speaking of free plant surveys I do not, of course, refer to every case of engineering advice and service offered by large companies in the mechanical field. Our company appreciates the advice and cooperation offered by the engineers connected with the selling organizations of certain companies and generally takes advantage of these services when considering major purchases, but we have no faith in the type of concern that attempts to shroud the use of its product in mystery and finds it necessary to charge exorbitant prices for its material to cover the cost of elaborate surveys or other advertising stunts.

C. W. SCHWABE
Superintendent Mechanical Department
Mallinckrodt Chemical Works
St. Louis, Mo.

PROFESSIONAL engineers should be called in regularly to make surveys of the plant, its equipment, and methods of production.

The outside engineer is usually a man of broad and varied experience. Every organization should at times be inspired with new ideas. A man who has had extensive experience in other plants naturally possesses a fund of knowledge that is not restricted to any specific shop. Fundamentals are of real significance to him, no matter to what product they may be applied.

The purchase of ideas has led to success in many plants. A periodic plant survey by a competent professional engineer offers a fertile source of ideas, for it will enlighten the owner as to the possibilities of certain methods for carrying out the work, or the need of improved equipment that the engineer knows is available.

The best way for any concern to make sure that it is using up-to-date methods is to distrust its present methods—to question the value of the machines and processes being used in its plant.

Plant engineers, foremen, and other executives benefit, as well as the plant itself, when a professional survey of equipment, methods, and processes is made by an outside engineer, for the different viewpoint of another man often solves a difficult problem.

Many manufacturers fail to utilize new improvements and discoveries made in the mechanical industry because they believe that the conditions in their shops are entirely different from those used in other plants. When the results obtained in other shops are mentioned, further consideration of the subject is too often dismissed with the words: "Our problem is different."

HARRY KAUFMAN, *Engineering Department*
Naval Aircraft Factory, Philadelphia, Pa.

QUESTIONS and ANSWERS

Oil- and Acid-Resisting Floor Covering

I should like to have some information in regard to a good material for covering a concrete floor which in some places is subjected to acids, and in other places to oil. Several floor coverings have been tried, but all have failed. W.H.H.

Chicago, Ill.

■

Welded Rotary Converter Damper Bars

Kindly inform me of the effect, good or bad, if damper bars of a rotary converter are welded instead of bolted—the latter having been done when originally manufactured. E. W. B.

Norfolk, Va.

■

Motor Runs Below Synchronous Speed

I have a 2-hp., three-phase, 60-cycle, four-pole, 550-volt, type KT G.E. motor that will not come up to speed. It has 36 slots and is wound with 36 coils having 40 turns of No. 18 wire, and connected one circuit star. The span of the coils is I-8 slots. The rotor has a cast aluminum winding and is ok. It has 51 slots. There is about 0.015 in. air gap between the rotor and the stator. With the motor-generator test set running at full speed this motor will turn at about 150 r.p.m. and has considerable torque. If the m.g. set is slowed down to about 45-cycle speed the motor takes hold and runs in synchronism. On testing the original winding we could not find any defects in it, but concluded there was something our tests failed to show and rewound the motor. It had been in operation for some time. Can someone explain why this motor runs below synchronous speed? T.S.E.

Baltimore, Md.

Please submit answers promptly. We expect to publish no answers later than the second issue following the appearance of the question. Selection will be made on the basis of quality, but answers first received have the best chance of being used

■

How Take Down Sheet-Iron Smokestack?

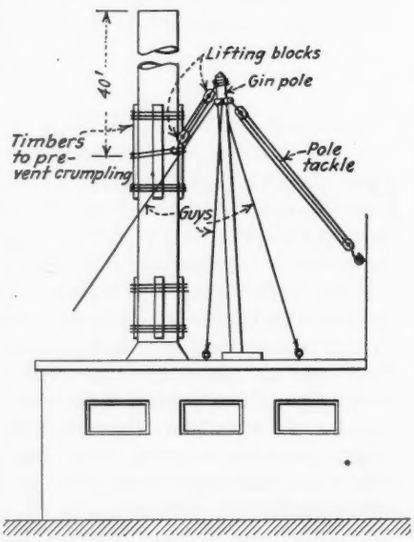
It is necessary for us to remove a sheet-iron stack 36 in. in diameter and 90 ft. high, which we want to salvage for further use. We need information on the best method of procedure, and will appreciate it. J. E. K.

Newllano, La.

I BELIEVE that J. E. K. will find the following ideas of use in removing his stack safely. I presume that the stack is on the top of a boiler house or some other such building. To remove the stack in one piece it will be necessary first to lift it clear of the breeching or foundation and then swing it out past the wall and thence to the ground. If taken down in sections it will be necessary to build scaffolding a few feet higher than the top of the stack so that the blocks and tackle may be cleared in pulling up to free the stack section. The sections then may be swung to one side and lowered on the inside of the scaffolding. Which means, of course, that the scaffolding must be large enough to accommodate two stack sections side by side, with at least six inches clearance. The more the better.

I believe that it will be cheaper and more satisfactory to remove the stack in one piece. If this is done a gin pole about 60 ft. high will be required. Good sound 10x10-in. timber can be used safely if well guyed. To prevent buckling this timber should have four 2x10-in. timbers, 20 ft. long bolted on all four sides about 35 ft. from the end of the pole intended for the bottom. If a 12x12-in. pole is used this bracing will not be necessary. A top cap and a foot block should be used with the pole. If they are not obtainable lash a heavy steel sheave to the top of the pole with steel cable and use at least three clamps. Guard the lower end of the pole with an iron ring to prevent splintering and set this end in a loose fitting cradle, which should be bolted to the pole foundation to prevent sliding. The gin pole, which should be well guyed on all sides, may be raised by using a 40-ft. pole.

Before attempting to lower the stack it should be reinforced on the inside to prevent buckling, especially at the point where the lifting tackle is used. Timbers should also be lashed on the outside of the stack to prevent crumpling under the lifting tie. These timbers



should be about 20 ft. long. If the stack is constructed of 10-gage steel, or close to this, an 11-in., four sheave hemp block will lift it. A six or eight sheave block should be used for the pole block. A 1-in. block will be necessary for tilting the gin pole so that the stack swings clear of the roof. With all

tackle in place and a strain taken on the lifting tackle, the stack may be cut away or unbolted from the breeching. The tackle should then be tightened and the stack raised slowly. It will swing out about 20 deg. if the lower guy is not snubbed. The snub should be released gradually and the stack allowed to swing.

When everything is steady the gin pole should be tilted slowly outward to enable the stack to swing over the side of the building. It will, of course, be necessary to wedge the lower end of the stack, after it is cut away. Also, as an added precaution, I would suggest lashing timbers on the outside of the lower end of the stack to keep the end intact when landing. If the stack does not swing clear of the building it may be necessary to pull it over with blocks. The guys should be snubbed around round posts or pipes, so that they may be released as required.

GRADY H. EMERSON.
Birmingham, Ala.

■

Using Flexible Couplings on Lineshafts

We have found it almost impossible to keep several of our lineshafts properly aligned. These shafts range from 50 to 100 ft. in length and are mounted in babbitt bearings. The building is of mill-type construction and widely varying loads on the floor above, over which we have no control, change the alignment almost from day to day. Equipping the lineshafts with self-aligning ball-bearing hangers and using flexible couplings, instead of the solid type now used, has been proposed. If any readers have tried this expedient, I wish they would let me know what results were obtained. M.L.

Chicago, Ill.

USE of flexible couplings and self-aligning ball bearings on lineshaft installations is quite feasible, but in the present case, I think a thorough check-up might save this expense. Apparently the lineshafts are installed away from the walls and supporting columns. Loads on the upper floor are depressing the ceiling below and the greatest deflection will occur in the center of the floor beams where the troublesome shafts probably are located.

If possible, the lineshafts should be moved away from the beam centers. Also, care should be taken to see that the bearing cap and side screws are not set up too tightly. This precaution will avoid hot and burned-out bearings. If the shafts cannot be moved as suggested, flexible couplings and self-aligning bearings are the only cure.

WILLIAM CUMPSTEY.
New Departure Manufacturing Company
Meriden, Conn.

Why Won't This Motor Operate as a Generator?

Recently I bought a used d.c. motor, of about 1 hp., which did not have any name plate data, and I am at loss as to its exact rating. However, I connected it to 110 volts d.c. and it ran satisfactorily. It is a two-pole, compound-wound machine. The field poles are laminated. I wish to convert it into a generator for testing purposes. I tried various connections and directions for different speeds, but it simply won't generate, although I do get a very small deflection on a low-reading d.c. voltmeter. The armature tests O.K., and so do the field poles. The shunt winding consists of about 7,000 turns of No. 34 wire, and the series winding of 50 turns of No. 22. The coils test out O.K.

J. R. M.

Indianapolis, Ind.

ASSUMING that this machine is in good mechanical condition, without excessive play in the bearings and with brushes and commutator smooth and making good contact, the probable cause of the trouble is in the field connections. If connections are such that the series field aids the shunt field when the machine is operated as a motor, it will buck the shunt field when driven mechanically in the same direction in an attempt to make it operate as a generator, due to the fact that the current through the armature must reverse under these circumstances.

The connections may be checked by testing as a motor, first with the shunt field alone, short circuiting the series field, then with the series field alone, disconnecting the shunt field. If the motor operates in the same direction in both cases, the leads from the series field must be reversed, so that, as a motor, the machine will operate in the opposite direction on series field alone.

Of course, the machine can be operated as a shunt generator, without using the series field. If it fails to generate in this condition, the trouble must be due to poor mechanical or electrical condition, assuming that it is driven in the same direction in which it operates as a shunt motor, at a slightly higher speed, connections remaining the same.

Morgan Brothers
Galva, Ill. N. G. MORGAN.

I HAVE found that a laminated pole d.c. motor has not enough residual magnetism in the poles to build up sufficient current to generate.

The laminated poles should be taken out, soft iron poles inserted, and the motor run on proper line voltage for several hours to give them residual magnetism. It can then be driven as a generator by some mechanical source.

Give the fields time to build up. That is, let magnetism in the poles act as a very weak self exciter. Sometimes it takes half a minute or longer to build up to rated voltage.

R. W. BOTTHELT.
Arc Electric and Elevator Repair Company
St. Louis, Mo.

■

Proceedings of Testing Society Meeting

THE PROCEEDINGS of the Thirty-Fourth Annual Meeting of the American Society for Testing Materials, held at Chicago, June 22-26, 1931, have been published in two volumes, each of some 1,000 pages.

Part I contains the annual reports of the Society committees and the papers and standards appended thereto. The president's annual address and the annual report of the executive committee are also included. The reports of the standing, research and sectional committees which function in the metals fields involve such subjects as the effect of temperature on the properties of metals, yield point of structural steel, wrought iron and wrought steel pipe and tubing, corrosion of iron and steel, zinc coating of iron and steel, and fatigue of metals.

Fatigue tests of low-carbon steel at elevated temperatures, low temperature endurance testing, creep testing apparatus, correlation of cast iron test bar and casting by volume surface ratio, and bibliography on embrittlement of structural steel in galvanizing are included.

Non-ferrous metals and alloys, electrical-heating, electrical-resistance, and electric-furnace alloys, copper and copper alloys, die-cast metals and alloys, light metals and alloys, and corrosion of non-ferrous metals and alloys are reported upon. Appended papers discuss the effect of composition on aluminum-base die-casting alloys, and lead-base and tin-base alloys for die castings.

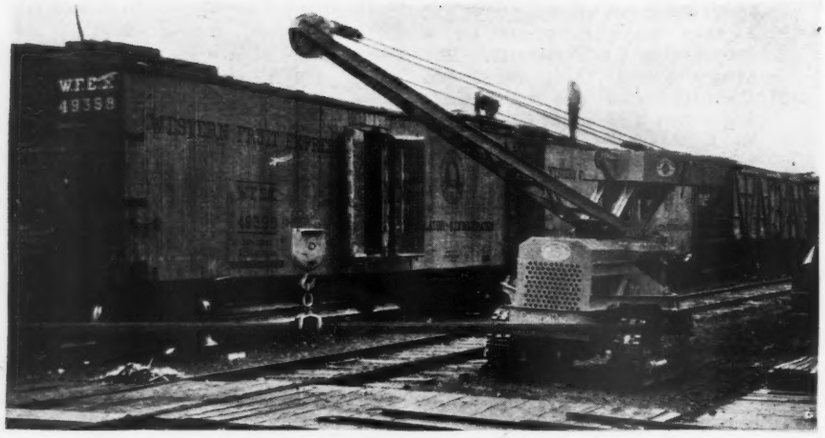
Committee reports involving non-metallic materials cover concrete and concrete aggregates, fire tests of materials, gypsum, and hollow masonry building units.

Other appended papers discuss concrete curing, pavement-core drilling practice, analysis of fresh concrete, determination of cement content of set concrete, and elastic properties of concrete. Added are reports of committees on preservative coatings for structural materials, petroleum products and lubricants, road and paving materials, coal and coke, timber, classification of coals, bituminous waterproofing and roofing materials, electrical insulating materials, rubber products, textile materials, thermometers, slate, and natural building stones.

Part I contains 74 tentative standards which have been officially adopted and published in 1931 for the first time. Several tentative revisions in standards also are included.

EQUIPMENT NEWS

Industrial plant executives concerned with the selection and operation of mechanical and electrical equipment will be interested in these devices, which are designed to improve plant operation or reduce operating and maintenance costs



Hughes-Keenan Revolving Tractor Crane

A full revolving crane for mounting on a Caterpillar Model Twenty tractor has been announced by The Hughes-Keenan Company, Mansfield, Ohio. Power for slewing or swinging the boom is furnished by a multi-cylindered hydraulic motor that operates at a maximum pressure of 300 lb. per sq.in. from a hydraulic pump at the rear of the tractor. The standard boom is 12 ft. long and, when set at an angle of 45 deg., it will handle a maximum load of 5,000 lb. Special lengths of booms can be furnished up to 18 ft. in length. Load capacities, of course, will decrease with the longer booms. The load line is operated from the same hydraulic motor that is used for slewing. Lifting speed, when the motor is operating at governed speed, is 30 ft. per min. The boom may be raised and lowered at will by power. All movements of hoisting and slewing are independently controlled, thus permitting their simultaneous or alternate operation.

A stabilizer is provided that consists of a double-acting hydraulic cylinder in which a piston reciprocates in harmony with the oscillation of the crawler assembly. The cylinder is provided with a valved passage extending axially from end to end and arranged to by-pass the oil, with which it is filled, from one side of the piston to the other when the valve is open to conform with movement of the piston. Closing of the valve locks the oil above and below the piston and thereby prevents any movement of the piston. No external pressure is used.

The hydraulic control permits holding the load at any point with safety and spotting of the boom at any desired point in the swing circle. Complete control is obtained by manipulation of control valves. The mounting has been arranged to permit full visibility for the operator.

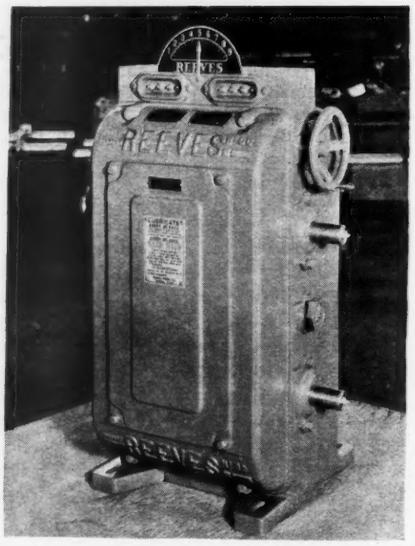
■

Reeves Vertical Variable Speed Transmission

To complete its line of inclosed, variable speed transmissions the Reeves Pulley Company, Columbus, Ind., announces a vertical unit. This model was developed to meet the requirements of certain standard equipment installations and installations requiring a mimimum of floor space for the speed control unit. A dust-proof, oil-tight cast iron case completely incloses all operating parts. The side cover may be taken off by removing four cap screws. The lid also may be removed for inspection of internal parts or minor adjustments. U-shaped recesses in the other section of the case permit the removal of all operating parts.

The unit can be lubricated completely without removing the cover section. All radial shaft and thrust bearings are lubricated through force-feed fittings located in two exterior panels. Shafts, driving keys, and disk hubs are lubricated by means of force-feed fittings in each end of the shaft extensions. From the eight force-feed fittings in the panels rigid copper tubes lead to the four radial shaft bearings, and flexible copper tubes lead to the four thrust bearings. Holes are drilled completely through the shafts, and force-feed fittings are inserted in the shaft ends. Outlet holes connect these channels with the surface of the shaft and with the bore of the disk hubs, so that the spiral lubrication grooves in the disk hubs always are filled with lubricant. After the transmission is in service lubrication is necessary every 30 to 45 days, depending upon the type of service.

Units are available equipped with electric-remote, electric-automatic, and mechanical-automatic controls and with motors, motor bases, and other accessories for varying requirements of speed control. The motor rails are



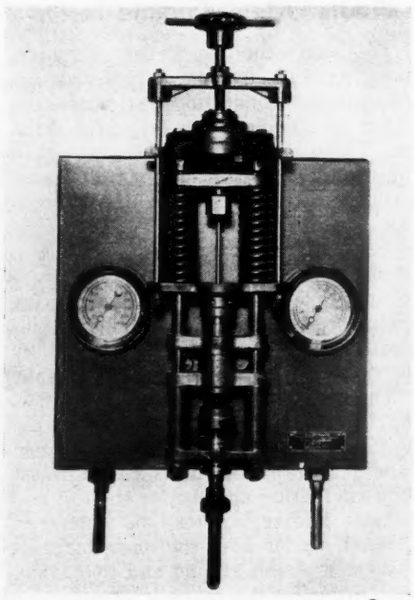
mounted so that the lid of the cover section is entirely accessible for removal. The cross rails, on which the motor is mounted, are slotted for adjustment, and they accommodate any design or type of motor consistent with the size of the transmission used. The motor base is adjustable vertically. The motor also may be adjusted for

alignment on the rails of the motor base. For extreme reduction in speeds an auxiliary countershaft may be installed. The transmission is available in ten sizes, covering speed ratios of from 2:1 to 8:1 inclusive.

■

Bailey Relay Pressure Valve

Bailey Meter Company, Cleveland, Ohio, announces a relay pressure valve, known as Style G, that is designed to give extremely accurate pressure control of steam, water, or gas lines. The valve controls the pressure within close limits by regulating the movement of a sylphon- or piston-operated throttle valve installed in the line in which the pressure is to be controlled. A minute change in the controlled pressure will

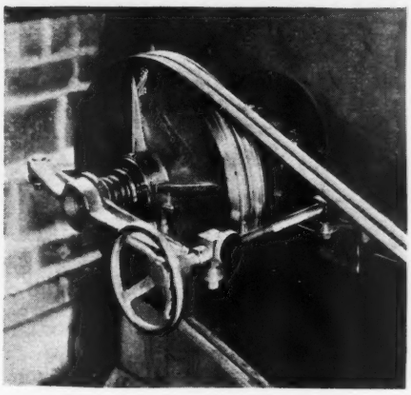


result in a relatively large change in the motive pressure used to operate the regulating valve. The position of the seat gap can be changed by adjustment of micrometer adjusting nuts to obtain any desired speed or lag in the amplified pressure connection. The range of applications of this valve is unlimited because it can operate one or a series of valves or pistons.

■

Smith Variable Speed Unit

The Smith Power Transmission Company, Penton Bldg., Cleveland, Ohio, announces the development of a variable speed unit known as the I.V.S. unit. The device is mounted on the driven shaft where variations of speeds are required. By turning a hand wheel or screw the speed can be adjusted from zero to a maximum speed for a set

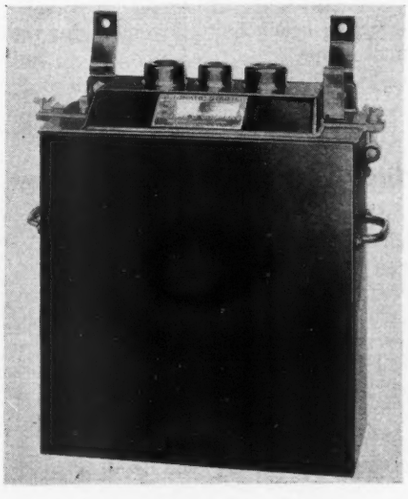


ratio. Ratios can be obtained as high as 9 to 1. The unit is constructed so that it can be used as a driven pulley for flat belts, a driven sprocket for silent or roller chains, or a driven sheave for V-belts. It also can function as a clutch when used with high torque motors. No special supports, bases, or foundations are needed to mount the unit. The units are available in ratings up to 5 hp. for the previously described types of drives.

■

Square D Explosion-Proof Starters

Class 8528 explosion-proof a.c. automatic starters have been announced by the Industrial Controller Division of the Square D Company, 710 South Third St., Milwaukee, Wis. They have been approved by the Underwriters Laboratory for use in Class 1, Group D hazardous locations. The starters are of the oil-immersed type and control across-the-line single and polyphase motors. Each starter consists of a cast iron head, a welded steel tank, and a starter panel. The head casting, which is provided with brackets for wall mounting, supports the steel angle frame to which the starter panel is secured, and the oil tank. The panel consists of a three-pole magnetic contactor and

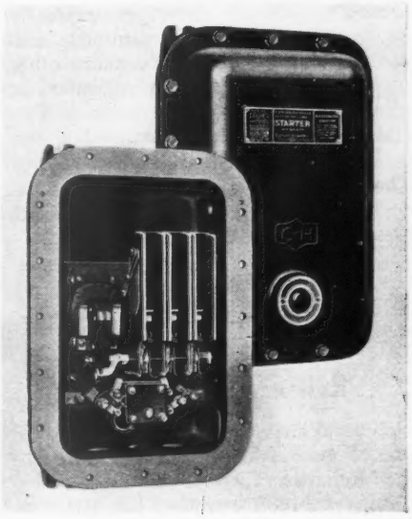


two oil dashpot overload relays. A visible gage indicates the maximum, normal, and minimum oil levels of the tank. The oil, in which the terminals and electrical parts are immersed, will prevent an arc passing to the surrounding fumes and gases. The starters are available in ratings up to 75 hp. for 220-, 440-, and 550-volt service.

■

Cutler-Hammer Explosion-Proof Automatic Starter

Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis., announces an explosion-proof, across-the-line, a.c. automatic starter. It is designed in accordance with the specifications of the Underwriters Laboratories for class



1, group D hazardous locations. The starter is of the air-break type, and there is no oil tank. The cast iron inclosure is designed to prevent any internal explosion from igniting the surrounding explosive atmosphere. The starter proper consists of a standard three-pole, magnetic contactor with thermal overload relays to protect the motor from burnouts caused by overloads. The units are available in three sizes for motors up to 30 hp., 220 volts and 50 hp., 440 or 550 volts.

■

Coppus Cable Manhole Ventilator

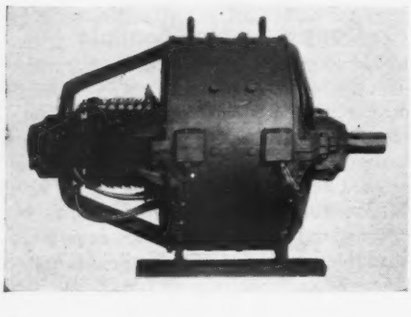
Coppus Engineering Corporation, Worcester, Mass., announces a cable manhole ventilator designated as size No. 150 S.M. It has a capacity of 950 cu.ft. per min. of free air. The unit is built around the "Vano" blower which is provided with non-overload characteristics. It is driven by a ¼-hp., 110- or

220-volt universal motor. The ventilator is mounted by a vertical swivel on a tripod. By means of a flexible canvas air tube attached to the diffuser the volume of air may be directed where needed. Although developed expressly for ventilating cable manholes and vaults the ventilators have many other applications, such as ventilation of sewers under construction, shipholds, tanks, silos, coal bins, confined spaces in chemical plants, and oil refineries. The outfit weighs 74 lb. and is equipped with a switch and circuit breaker, 12 ft. of cord, and a plug.

■

Reliance D. C. Motors

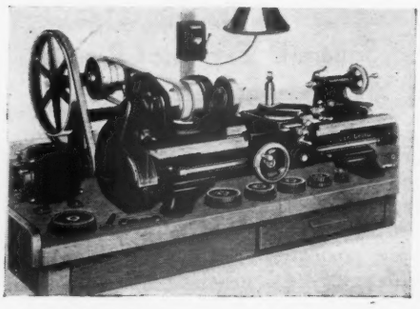
Several large sizes of its Type T, d.c. line of motors have been announced by the Reliance Electric & Engineering Company, 1088 Ivanhoe Road, Cleveland, Ohio. The motors range in size from 100 hp. at 800 r.p.m. to 350 hp. at 1,200 r.p.m. Rolled steel, split-frame construction is used. The feet and supporting members are welded to the frame. Each motor has six main poles and six commutating poles. Metal bobbins are used for the field coils. Brackets and sleeve bearings are of split design. Two oil rings at the front end and three oil rings at the back of each motor keep the bearings lubricated. Brush studs are made of steel, cadmium plated. Fiber insulation is used for the studs. Hard-drawn copper bars are used for the commutator. The leads are brought through both ends of the frame and held in place by wood cleats. No terminal board is used so that the connections can be completely taped. The motors may be supplied for constant-speed or for adjustable-speed service with a 2- to 1- or a 3- to 1- speed range.



■

South Bend 8-In. Bench Lathe

South Bend Lathe Works, South Bend, Ind., announces a back-geared, screw-cutting, precision lathe for general purpose applications. It is known as the 8-in. Junior. The unit is constructed to include a back-geared headstock with a three-step cone which provides six changes of spindle speeds. Among the mechanical features are a hollow spindle of alloy steel; a precision lead screw $\frac{3}{4}$ in. in diameter; an automatic, longitudinal feed to the carriage; a tailstock set-over for taper turning; and a screw thread chart by which the number of threads may be varied from 4 to 40 per in. Bed lengths available are 24, 30, 36, and 42 in. All types

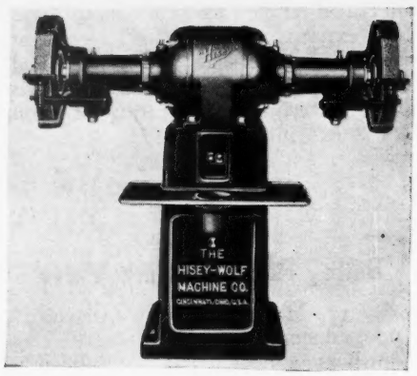


of turning, facing, boring, chucking, drilling, tapping, tapering, reaming, grinding, and polishing work may be done with this lathe and, if desired, attachments are available for special work. Motor driven lathes are equipped with 1,800-r.p.m. motors and drives. Each motor receives its power supply from an electric lamp socket. The type shown in the illustration is called the horizontal motor drive; it is a self-contained bench unit convenient for the small shop.

■

Hisey-Wolf Wide-Swing Grinders

Wide-swing, electric bench and floor grinders in $2\frac{1}{2}$- and $3\frac{1}{2}$-hp. ratings have been announced by The Hisey-Wolf Machine Company, Cincinnati, Ohio. Each machine is equipped with four oversize ball bearings completely inclosed against dust and grit. Motors are inclosed and dust proof and may be of any standard a.c. or d.c. type. Lubrication is obtained by means of conveniently located cups; a drain plug



permits flushing of the bearings and chambers. Inspection covers on the end bells permit full access to the machines while they are in operation.

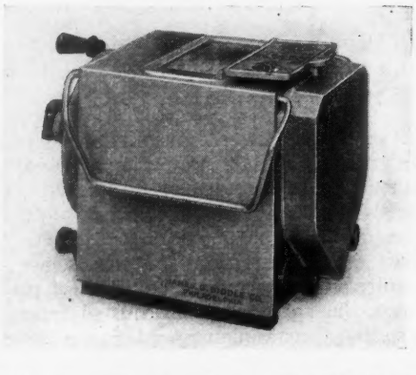
■

Biddle "Meg" Ground Tester

To meet the need for a small, direct reading instrument for measuring ground connection resistance the James G. Biddle Company, 1211 Arch St., Philadelphia, Pa., have developed the "Meg" ground tester. The instrument is mounted in a cast aluminum case with over-all dimensions of $5\frac{1}{2}$ x 9 x 6 in. It weighs $7\frac{1}{2}$ lb. Use of the tester eliminates the necessity for multiple tests and calculations for ground resistance. The instrument indicates directly without adjustment by the deflection of a pointer over a scale.

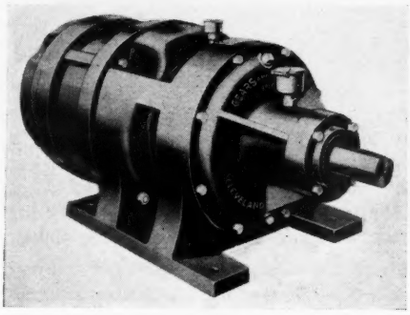
The operating principle is the same as the "Megger" ground tester in that the unit is provided with a self-contained hand generator that furnishes the necessary alternating current for the test and a direct reading, pointer-type ohmmeter.

When under test the instrument is connected to the ground and two reference grounds; the crank is turned; and the ground resistance is read in ohms. The instrument is reported to be unaffected by polarization, electrolysis, or by stray currents in the earth. The tester is available with ranges up to 300, 600, and 1,000 ohms. The scales are logarithmic in character. In addition to its general-purpose applications the tester is intended for routine tests of transmission towers and lightning arresters.



Gears and Forgings Motorized Speed Reducer

A speed reducer of the planetary type built integral with an electric motor to form a single unit has been announced by Gears and Forgings, Inc., Cleveland,



Ohio. The device is known as a motorized speed reducer. It is designed especially for applications in which the available space for the driving mechanism is limited. The reduction gear housing is dust-proof and oil-tight. The gear unit imposes no additional load on the motor shaft, which is supported by two ball bearings. The motorized reducers are built in standard ratios ranging from 4:1 to 240:1, and in sizes ranging from ¼ hp. to 30 hp. inclusive.

■

Westinghouse Unit-Built Motors and Speed Reducers

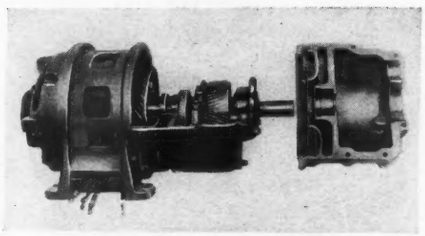
Unit drives, known as Gearmotors, for powering motor driven equipment that operates at reduced motor speeds have been announced by the Westinghouse Electric and Manufacturing Company, Pittsburgh, Pa. The drives consist of speed reducers combined with motors to form self-contained units which are only a few inches longer than the motors alone.

Advantages afforded by this combination of power and speed reducing equipment include economy in space requirements, simplified installation, and a reduced number of drive parts. Each unit includes a Type CS general purpose induction motor and a double reduction, non-planetary type, helical gear speed reducer built onto the one piece motor frame. Pre-wound primary cores that are separable from the stator frame are used in the motors. This feature permits quick changes of motor speed, voltage, and phase. Dual treated windings, directed ventilation, and ball bearings are other motor construction features of the drives.

The speed-reducing mechanism is fully inclosed in a two-piece housing which is bolted to the motor frame. The desired reduction of motor speed is obtained by heat-treated helical gears and pinions. All gear and pinion shafts are supported on roller bearings. By a splash system of lubrication all moving parts of the speed reducing mechanism and one motor bearing receive a supply of oil continuously during operation. The other motor bearing is packed with grease. The lower section of the housing forms a reservoir for lubricant. Seals on all shafts prevent oil from escaping into the motor windings and to the outside of the unit at shaft apertures. Adjoining faces of the two sections of the housings are bolted together to form an oil tight, dirt proof inclosure. No gaskets are used. Plugs for checking the oil level and refilling or draining the oil supply are provided. Ventilating air for the motor is admitted through an opening in the lower section of each speed reducer housing; the air is directed by a curved shield integral with the interior of the housing.

Accessibility to all parts is obtained by removing the top section of the housing. This job can be done without removing the drive from its mounting or uncoupling it from the driven equipment. After removing the motor bearing bracket, the complete rotor assembly can be pulled out.

The units are built in sizes from ½ to



15 hp. with a wide selection of output ranging from 69 to 1550 revolutions per minute.

■

Lincoln Time Delay Switch

A totally inclosed time delay switch designed to be unaffected by temperature changes or operating conditions has been developed by The Lincoln Electric Company, Cleveland, Ohio.

In a way the switch may be likened to an hour glass because its principle of operation is the slow movement of mercury from one chamber to another. When the switch is in the "off" position it is in a horizontal position and the mercury is in a lower chamber. Wire connections are tapped to the upper compartment. When the switch has been turned so that it is in a vertical position mercury begins to flow into another cavity through a small opening. As the mercury rises it completes the circuit at the various taps. By changing the position of the connections to the different taps variations in time delay are secured. By varying the size of the small opening at the bottom the switch can be manufactured to give any time delay desired between 2 and 20 sec. When the switch is turned off—that is, when it resumes its horizontal position—the mercury passes through a large opening into the lower chamber and breaks the contact. The device is mounted in connection with a contactor switch so that, when the main switch goes in, the delay switch is changed immediately to a vertical position and, when the main switch is thrown off, the delay switch is returned to the horizontal position.

■

Ohmite Rheostats

Ohmite Manufacturing Company, 636 North Albany Ave., Chicago, Ill., announces that the line of 50-watt rheostats made available several months ago has been increased to include several new resistance values.

The rheostats employ a porcelain base and a horseshoe-shaped porcelain core to support the winding. The units, 2¼ in. in diameter and less than 1¼ in. in depth, are vitreous enameled, with the exception of the surface on which the contact arm rides. Their range, formerly 2 ohms to 10,000 ohms, now includes values from 1 ohm to 35,000 ohms.

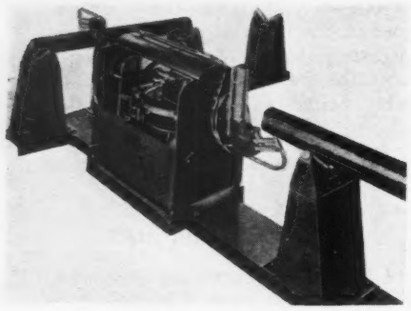
■

Wheeler Portable Floodlights

Wheeler Reflector Company, 275 Congress St., Boston, Mass., announces a line of portable floodlights. The units can be mounted on pipe, walls, in the ground, or on roofs. Each reflector is adjustable, vertically or horizontally, to any angle desired. The floodlights are available in three sizes, accommodating 75- or 100-, 150- or 200-, and 300- or 500-watt lamps. Each unit is equipped with a spike for ground mounting and a socket, service cord, and plug.

Douglass Pipe Fitting Machine

The Douglass pipe fitting machine has been announced by H. A. Brassert & Co., 310 South Michigan Ave., Chicago, Ill. It is designed to cut automatically

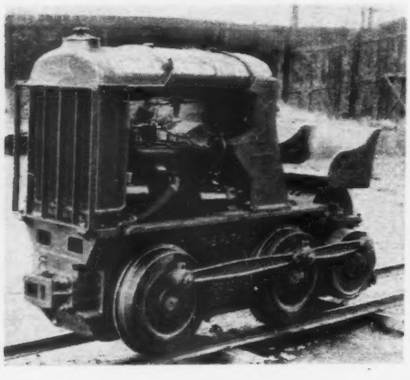


pipe 2 to 18 in. in diameter for fabrication into welded tees, miter elbows, and bull plugs by means of an oxy-acetylene flame. It also bevels plain end pipe for butt welds. The mechanical movement of the cutting torch is a combined rotating, longitudinal, and angular motion so that the correct bevel is produced in the pipe at any point. By the use of two heads on the machine the header pipe and the branch pipe may be cut simultaneously with the same generating mechanism so that a close fit of the two parts of the tee is assured. Parts as they come from the machine require no further preparation for welding. Other advantages claimed are that pipes can be cut on the machine in less time than it takes to lay out the work for hand cutting, and that no templets or patterns are needed.

■

Ruth Mine-Type Locomotive

For industrial applications requiring minimum clearances The Ruth Company, Denver, Colo., announces an 18-in. gage, gasoline-powered, mine-type locomotive. The machine is 31½ in. wide, 52 in. high, and 86 in. long. It is equipped with a 10-gal. radiator. The narrow width and low center of gravity are made possible by its side-rod drive. The total braking surface of 300 sq.in. is applied uniformly to each of the four wheels. Heat-treated alloy steel gears, Timken roller bearings and an inclosed steel gear case are other mechanical features of the locomotive. The gear mechanism is arranged to give five speeds in a forward or reverse direction. Power is furnished by a Ford Model AA motor. The locomotives are available in 2-, 2½-, 3-, 3½-, 4-, and 5-ton sizes.



■

Appleton Explosion Resisting Fittings

Series GRU and GRUY "Unilets" are the trade names given to a line of explosion resisting fittings announced by the Appleton Electric Company, 1701 Wellington Rd., Chicago, Ill. The fittings have been designed in accordance with the requirements of the Underwriters Laboratories for use in Classes 1 and 2 hazardous locations. Bodies are made of malieable iron, and covers are composed of cast brass. The metal to metal joints are machined so that no gaskets are required. Units can be

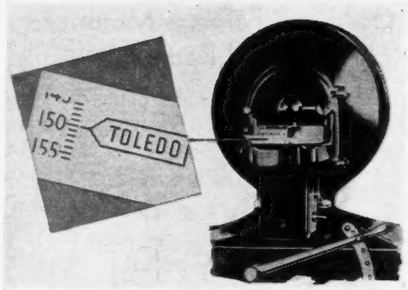
furnished with rotary or toggle switches. Both of these switches are operated by means of a shaft extending through the bearing surfaces.

■

Toledo "Printweigh" Automatic Scale

Announcement is made by the Toledo Scale Company, Toledo, Ohio, of the development of an automatic scale, known as the "Printweigh," that prints the weights clearly and indelibly on an inserted ticket.

When the scale is in operation a ticket large enough to accommodate 20 weight figures is inserted in a slot in the back of the dial. When the weight is placed on the platform the automatic indication comes to rest according to common practice. This indication can



be read by the operator from the back of the scale where he has inserted a ticket. When this indication stops at the correct weight the operator touches a button which in 1/10 sec. prints the weight of the commodity on the ticket.

■

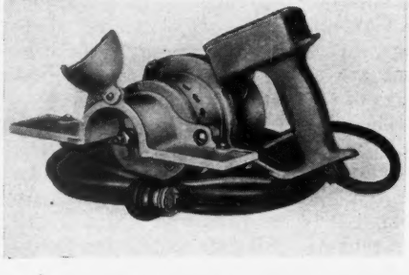
Aluminum Industries Aluminum Coating

"Permite Resalum" is the name of an aluminum protective coating announced by Aluminum Industries, Inc., Cincinnati, Ohio. It may be used on metal, wood, fabric, stone, or any combination of these materials. Characteristics claimed for the coating are that it is highly-resistant to heat, corrosion, and destructive elements.

■

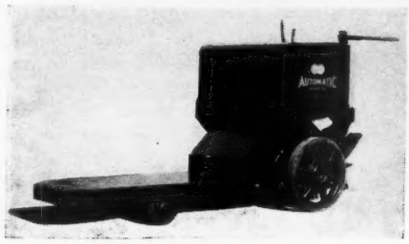
Protex Portable Electric Groover

Protex Weatherstrip Manufacturing Company, 2308 West 69th St., Chicago, Ill., announces the development of a machine known as the Protex portable electric groover. It is used for grooving wood weatherstrip, flooring, and the like. The cutter is 1⅛ in. in diameter and is available in widths ranging from 7/32 to 5/16 in. The guard may be adjusted to give a depth range of ½ in., and the in-and-out movement of the spindle permits a groove to be cut that is 1¾ in. deep from the top of the board. Other features include a cast aluminum case; ⅓-hp., high-torque motor with a no-load speed of 18,000 r.p.m.; a heat-treated steel shaft; a quick make-and-break switch in the handle; and grease-sealed ball bearings. The groover weighs 7½ lb. and is 12½ in. long and 10½ in. wide.



Automatic Model LG-2 Low Lift Truck

The Automatic Model LG-2 low lift truck, offered by Automatic Transportation Company, Inc., 101 West 87th St., Chicago, Ill., was made to supplement



hand equipment and to be used in connection with the handling of skid platforms. This model has a rated capacity of 4,000 lb. The spur gear drive used on all Automatic models has been applied to this equipment. Larger drive wheels are used and the truck is 10 per cent to 15 per cent faster than previous models of the same capacity, and was designed to maneuver in much closer quarters than was previously possible. This machine is suitable for congested industrial plant, terminal, warehouse, and railroad shop operation. It can be used with skids of any length, width or height. Safety of operation is insured through an interlocking foot controller.

■

Cutler-Hammer Duplex Receptacle

Announcement of a duplex flush receptacle is made by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. Contact pressure is supplied by an auxiliary steel spring which carries no current, so that the original "set" will not be destroyed because of overheating. The contacts, which are kept in alignment by bakelite back-up lugs, are designed so that the point of arc is at the flared lip, keeping the contact area of the clip proper free from burning and pitting.

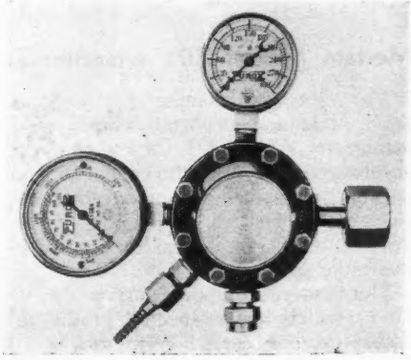
The body is of molded bakelite, with a finding ring which permits insertion of the cap blades by means of a slight clockwise turn. The heavy mounting yoke with reinforced channel back is keyed to the bakelite body to prevent shifting and the back plate is impregnated to prevent moisture absorption. Shallow construction permits a fit in any box.

This receptacle is known as the Catalog 7942-P. It is rated 15 amp., 125 volts; 10 amp., 250 volts.

■

Linde "Purox" Regulators

To supersede its former line of "Purox" metal Master type of regulators The Linde Air Products Company, 30 East 42nd St., New York, N. Y., announces an improved line of "Purox" oxygen and acetylene regulators. All welding or cutting outfits now include these regulators. The line consists of six units, designated as Nos. 33 and 34 for acetylene and Nos. 13, 14, 23, and 24 for oxygen. All regulators are of all-metal construction. The required volumes of oxygen and acetylene essen-



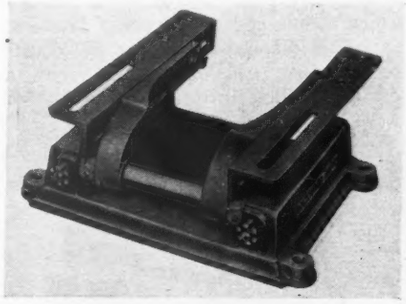
tial for maintaining a neutral flame at the blowpipe tip are delivered to the welding or cutting blowpipe at uniform pressure.

One of the design features of the regulators is an accurate self-aligning valve of the nozzle-and-yoke type, provided to insure sensitive action and freedom from leakage. The regulators are designed to eliminate the need for disturbing the diaphragm, bonnet, pressure adjusting screw, or pressure adjusting spring when replacing a worn valve seat. Access to the interior of the regulator is gained by removing a plug in the rear of the body. Diaphragms are made of a corrosion-resisting alloy. A rupturing-disk safety release on the oxygen regulator provides protection to the diaphragm should an abnormal pressure occur. To replace the diaphragm the cap bolts are removed, and the diaphragm and yoke lifted out. Gage cases are polished brass with beveled plate glass crystals. Diameters of the working pressure gages measure 2 in., and the cylinder pressure gages are 2½ in. in diameter. In accordance with the standard color specification for oxy-acetylene equipment oxygen regulators are painted green, and the acetylene regulators red.

■

Rockwood Redesigns the Base of Its Short Center Drive

The Rockwood Manufacturing Company, Indianapolis, Ind., announces that it has redesigned the base for its flat-belt, short center drive to provide greater adaptability and flexibility. The base is provided with adjustable arms which permit the use of a motor of any base dimensions and allow the motor to be moved nearer or farther from the

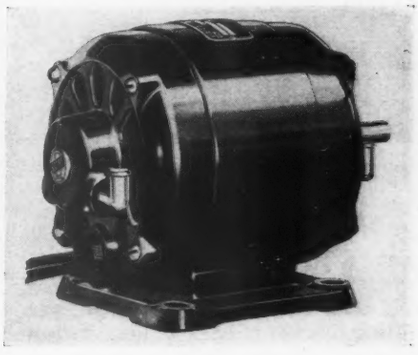


pivot shaft. The latter feature permits variation of the belt tension until it is at the best operating value for each drive by utilizing the proper portion of the motor's weight. Bases are available to accommodate motors ranging from 1 to 100 hp. in rating.

■

Bodine Type N-3 Motors

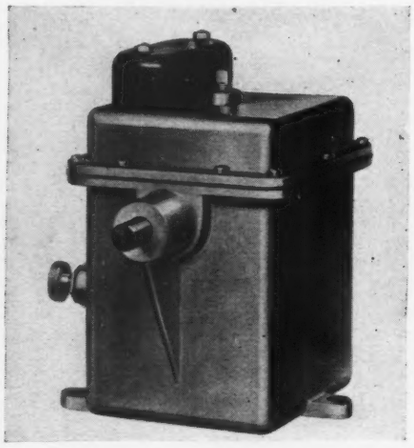
Bodine Electric Company, 2264 West Ohio St., Chicago, Ill., announces a line of small motors with wool-packed bearings known as Type N-3. They are rated at 1/20 and 1/15 hp. at 1,725 and 3,400 r.p.m., and 1/30 and 1/20 hp. at 1,125 r.p.m. Synchronous and split phase induction motors, and series and shunt d.c. motors are available. A simplified automatic cutout is another feature. Ventilating ducts are provided.



Barber-Colman Adjustable-Speed Damper Controllers

Damper controllers with speed regulating governors have been announced by the Barber-Colman Company, Rockford, Ill. Each governor is designed to allow for a wide range of speeds. The units are arranged so that the speed of the controller may be adjusted after installation without opening the controller case. The controllers may be used for a wide variety of work on both single- and multiple-louvred dampers in practically any heating, ventilating, or air conditioning system.

The governor is, in effect, a small reciprocating pump working against a variable head set up by the pressure necessary to force oil, with which the damper controller case is filled, past an orifice at one end of the pump cylinder. Variation in speed is obtained by adjusting the size of this opening with a screw threaded through the controller



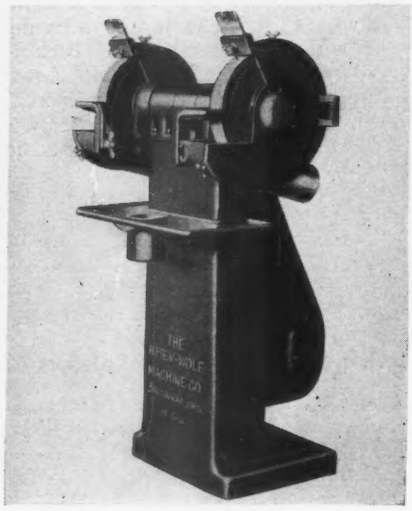
case. The starting or maximum torque is not reduced as would be the case if an ordinary brake were used. A fractional-horsepower induction motor of the shaded pole type actuates the controller and its governor. Cooling and lubrication of the controller mechanism is obtained by means of the oil in the controller case.

■

Hisey-Wolf "TexDrive" Grinder

The Hisey "TexDrive" grinder for 10-, 12- and 14-in. diameter vitrified or high speed grinding wheels is announced by the Hisey-Wolf Machine Company, Cincinnati, Ohio. The motor is mounted on the back of the pedestal, and connected by V-belt drive to the spindle.

Extra large ball bearings are mounted on a heavy shaft of special spindle steel. The bearing boxes which are keyed to the pedestal can be removed as a complete unit with the shaft, permitting renewal of belts without disturbing the bearings. Cast steel wheel guards pivot to any desired angle and have hinged covers for access to wheels. Spark shields are adjustable in steel box-type slides. The motor can be adjusted without removal of hood.



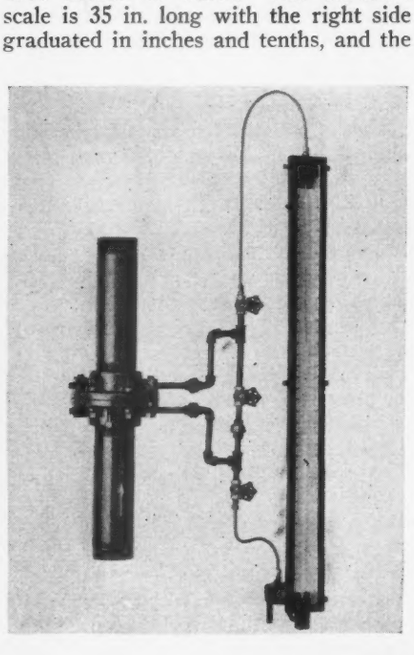
The machines can be furnished with or without motor.

■

Meriam Model 391 Manometer

The Meriam Company, Cleveland, Ohio, announces a portable high range manometer, Model 391, for checking the accuracy of recording flowmeters. This portable instrument has a steel frame, steel gland packers, plate glass cover, and is tested to 1,000 lb. per sq.in. hydraulic pressure.

Mercury, water, or Meriam No. 3 fluid (which has a specific gravity of 2.97), may be used. With the No. 3 fluid this manometer will read one hundred inches of water. The standard scale is 35 in. long with the right side graduated in inches and tenths, and the left side, for use with Meriam No. 3 fluid, zero to one hundred inches and tenths of water.



The manometer can be used as an indicating flowmeter. Orifice plate, flange, special scales reading direct in gallons, cubic feet, pounds, or any commercial units of measurement, liquid return well, control and bypass valves, are available for this purpose

The standard instrument is 42 in. high, 6 in. deep, 4½ in. wide, and weighs approximately 20 lb. Special instruments of any length and for higher pressures can be supplied.

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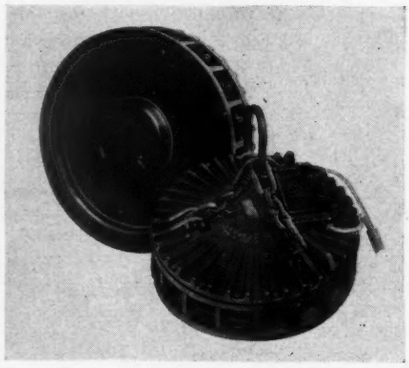
Cutler-Hammer Heavy Duty Lifting Magnet

A 30-in. size, heavy-duty lifting magnet has been announced by Cutler-Hammer, Inc., 253 North 12th St., Milwaukee, Wis. The unit is especially

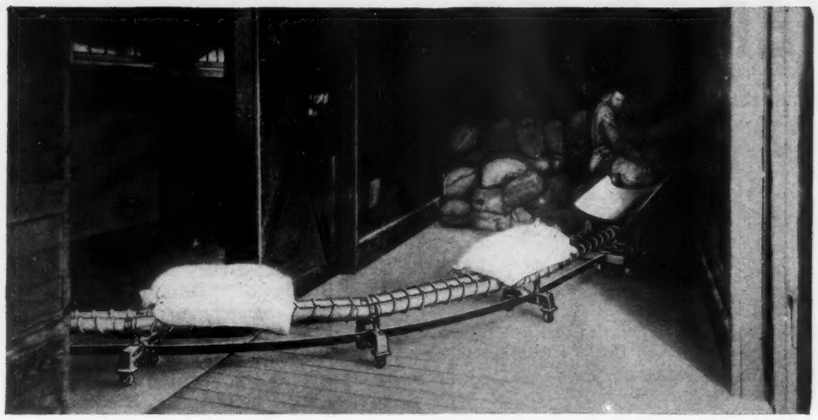


suitable for use with crawler type cranes in foundries, warehouses, and industrial plants where the size of the d.c. generator must be small and the lifting capacity of the magnet must be high. A 2½-kw. generator is required. The design of the magnet is essentially the same as that of the larger, "Red Top" lifting magnets for heavy duty service. The magnet case is of high permeability steel with renewable pole shoes of special steel. The magnet coil is of Deltabeston wire. After winding, the coil is treated by an insulating process which permanently holds the coil in place and fills all crevices of the magnet interior to make it waterproof. Each magnet weighs 1,300 lb. and is furnished with two protected connecting cables and two cable connectors.

■

Clark "Kar Kit"

"Kar Kit" is the name of an assembly of "TwinVeyor" sections announced by the Clark Tructractor Company, Battle Creek, Mich. The spiral conveyors are mounted on casters for easy

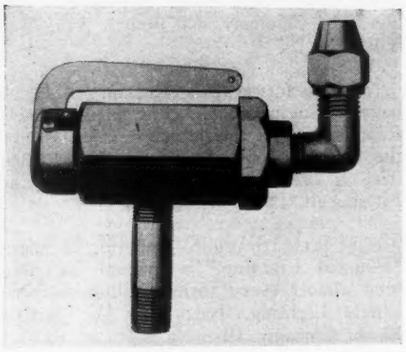


mobility, and the unit is provided with chutes for discharging the bags, bales, or bundles being handled. By its use bags travel into the freight car right to the spot where they are to be piled. They are presented to the piler at a convenient height for storing. As one end of the car is loaded the entire unit moves back and, when the center section is reached, the equipment can be turned around into the opposite end of the car. Slip-sleeve sections of the spiral conveyor tubes make it possible for the line to be turned right or left on entering the car door, still keeping the tubes parallel and on constant centers. One man can move the entire loading unit while it is in operation. Car unloading is simply a reverse of the loading operation.

■ ■

Linde P-O-L Primer

A device for facilitating the starting of gasoline engines, known as the P-O-L primer, has been introduced by The Linde Air Products Company, 30 East 42nd St., New York, N. Y. By its use acetylene is introduced into the cylinders of an internal combustion engine so that it will start easily and quickly. The unit consists essentially of a special stem-type brass tubing with compression unions. The assembly is used in conjunction with a "Prest-O-Lite" acetylene tank. The device is mounted on the intake manifold of the engine; its regulator is attached to the tank valve; and the two parts are connected with ¼-in. brass tubing. The regulator automatically reduces the tank pressure of the acetylene to a low line pressure, and the primer valve controls the flow of acetylene into the manifold. The valve is operated by a pull wire which leads from the valve lever through the dash if the vehicle has a self-starter, or through the radiator if hand cranking is employed. On a stationary engine the pull wire may lead to any point that is convenient when cranking. If the truck or tractor already is equipped with an acetylene tank, both primer and lighting system may be operated simultaneously from the same tank by the use of an adapter.



To start an engine on which the primer has been installed the usual procedure of spark and gasoline adjustment is followed, except that the primer is used instead of the full choke. Instead of raw gasoline the primer introduces into the cylinder combustible acetylene which fires easily and quickly. After a few revolutions it will pick up on the regular carburetor mixture. Claims made for the device are that it minimizes the strain on the starting system, eliminates excessive cranking, and reduces cylinder wear.

The primer, beside being adaptable to gasoline engines on automobile trucks and tractors, may also be used on stationary engines operating pumps, air compressors, or other equipment. The device is especially useful in cold weather when gasoline engines are hard to start.

■

"Alumaweld" Solder

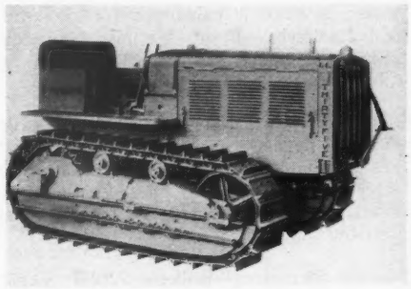
"Alumaweld," a solder for aluminum, pot metal, cast iron, brass, and all other metals, has been announced by the Alumaweld Company, Division of Allied Research Laboratories, Inc., 710 East Broadway, Glendale, Calif. It is marketed in sticks and is applied in the usual manner, with a blow torch or soldering iron.

According to the manufacturers, the solder will withstand water pressures up to 1,000 lb. per sq.in., and steam pressures up to 500 lb. per sq.in. It is also claimed that there is no electrolysis between this solder and any metal to which it may be applied.

■

Caterpillar "Thirty-Five" Tractor

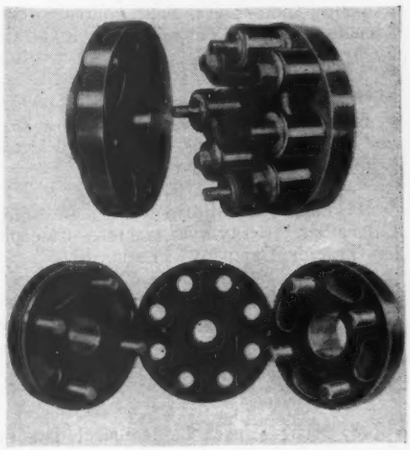
Model "Thirty-Five" has been added to the line of tractors made by the Caterpillar Tractor Company, Peoria, Ill. This machine develops 37 drawbar hp. and is of the same general design and construction as the rest of the line. It is powered by a four-cylinder, four-cycle, water-cooled gasoline engine, and has four speeds forward and one reverse. The shipping weight is approximately 11,700 pounds.



■

F. A. B. Flexible Couplings

A coupling compensating for parallel and angular misalignment, and embodying shock-resisting and vibration-eliminating features, is offered by the F. A. B. Manufacturing Company, 67th and Vallejo Sts., Oakland, Calif. The coupling, available in sizes up to 1,200 hp., is said to operate noiselessly at 3,450 r.p.m., and to require no lubrication.



TRADE LITERATURE

For copies, address the manufacturers concerned

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(37) CASTINGS—Bulletin 1250, Promal castings for power transmitting and conveying chains.—Link-Belt Company, 910 S. Michigan Ave., Chicago, Ill.

(38) STANDARDS—1931 Index to A.S.T.M. Standards and Tentative Standards.—American Society for Testing Materials, 1315 Spruce St., Philadelphia, Pa.

(39) POWER TRANSMISSION—"Vee-Tex" meter, a circular calculator for designing V-belt drives.—Pyott Foundry and Machine Company, 328 N. Sangamon St., Chicago, Ill.

(40) POWER TRANSMISSION—Leaflet 20536, 4 pages, "Gearmotors," speed reducers combined with induction motors, in sizes from ½ to 15 hp.—Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

(41) SWITCHES—Bulletin 720EP, explosion-proof, across-the-line starting switches.—Allen-Bradley Company, 1321 S. First St., Milwaukee, Wis.

(42) MOTORS—Bulletin 167, 30 pages, small motors for a variety of applications.—Wagner Electric Corporation, 6400 Plymouth Ave., St. Louis, Mo.

(43) RHEOSTATS—Form GEA-1084A, hand operated, plate type field rheostats.—General Electric Company, Schenectady, N. Y.

(44) MOTORS—Volume 1, Number 1 of "The Motorizer," a monthly magazine devoted to the design, construction, operation, application and maintenance of a.c. induction motors and their controls.—The Lincoln Electric Company, Coit Road and Kirby Ave., Cleveland, Ohio.

(45) BEAM CLAMPS—Folder GEA-1192A, 4 pages, galvanized beam clamps for steel and pipe structures.—General Electric Company, Schenectady, N. Y.

(46) TRACTORS—Form P-936, 36 pages, Caterpillar "twenty-five" tractor.—Caterpillar Tractor Company, Peoria, Ill.

(47) SWITCHBOARD DEVICES—Bulletin GEA 924B, 32 pages, design, construction and test data on indoor bus supports.—General Electric Company, Schenectady, N. Y.

(48) NUTS—Form 12, technical data on the use of elastic stop nuts.—AGA Company, Elizabeth, N. J.

(49) METERS—Bulletin 192, 8 pages, gravity recorders for liquids. These devices continuously record the specific gravity of a liquid and automatically correct their records for variations in the temperature of the liquid.—Bailey Meter Company, Cleveland, Ohio.

(50) BRASS PRODUCTS—General catalog 10, brass and bronze products for the industrial, automotive, building, and hardware trades.—The Imperial Brass Manufacturing Company, 1200 W. Harrison St., Chicago, Ill.

(51) SIGNALING EQUIPMENT—Bulletin 38, 8 pages, industrial signaling equipment.—Federal Electric Company, Signal Division, 8700 S. State St., Chicago, Ill.

(52) POWER TRANSMISSION—"Materials Handling and Power Transmission Data Sheet No. 4," power formulas for chain conveyors and elevators.—Link-Belt Company, 300 W. Pershing Road, Chicago, Ill.

(53) ANTI-FREEZE SYSTEM—Bulletin 100-C, improvements in the design of Tanner tanks and control of "Tannergas" used to prevent freezing of compressed air lines.—Sullivan Machinery Company, 400 N. Michigan Ave., Chicago, Ill.

(54) TEMPERATURE CONTROL—Bulletin 3060-V, illustrated description of the construction and operation of the Neilan non-recording temperature controller.—Neilan Company, Division of Mason Regulator Company, 641-651 Santa Fe Ave., Los Angeles, Calif.

(55) WELDING—Bulletin W-7, applications of the "Homoweld" for pressure and temperature equipment.—Henry Vogt Machine Company, Louisville, Ky.

(56) GEARS—Catalog, "Celeron" gears, applications for these gears, recommended practice, horsepower ratings, and sizes.—The Continental Diamond Fibre Company, Newark, Del.

(57) MAGNETIC CLUTCH—Bulletin 50, complete technical data on the "Sterns" multiple disk magnetic clutch.—Magnetic Manufacturing Company, Milwaukee, Wis.

(58) BEARING FRICTION—Bulletin 72, "Friction of Some Babbitt, Roller and Ball Bearings." Tests to determine the friction of some commercial lineshaft bearings under circumstances to warrant some fair comparisons of their frictional resistances.—The Engineering Experiment Station of the University of Wisconsin, Madison, Wis.

(59) EXHIBITIONS—Booklet, "How Exhibitors Are Meeting the Trade Show Problem."—Policyholders' Service Bureau, Metropolitan Life Insurance Company, New York, N. Y.

(60) OPTICAL INSTRUMENTS—Booklet, 126 pages, "Optical Instruments for Examining and Analyzing Metals."—Bausch & Lomb Optical Company, Rochester, N. Y.

(61) SHOP EQUIPMENT—Folder, electrically welded, pressed-steel bench legs.—Bond Foundry and Machine Company, Manheim, Pa.

(62) INSTRUMENTS—Bulletin 17, model 391, high-range manometer.—The Meriam Company, 1955 W. 112th St., Cleveland, Ohio.

(63) MATERIALS HANDLING—Folder, 4 pages, the "Fabriform" loader for Case Model "CI" tractor.—Welded Products Company, 4900 Cecilia St., Los Angeles, Calif.

(64) CHAIN—Catalog 525, 46 pages, steel thimble roller chains for drives, elevators and conveyors.—The Jeffrey Manufacturing Company, Columbus, Ohio.

(65) VALVES—Folder F-516, "Slaset" lubricated rotor valve.—The Lunkenheimer Company, Cincinnati, Ohio.

(66) PAINT—Folder, 4 pages, "Permite-Resalum," an aluminum paint.—Aluminum Industries Incorporated, Cincinnati, Ohio.

(67) POWER TRANSMISSION—Bulletin 112, 46 pages, gear reduction units, design, construction and application data.—The Cleveland Worm and Gear Company, 3300 E. 80th St., Cleveland, Ohio.

(68) WATER TREATING—Folder, 24 pages, "Hot Lime Soda Water Softening."—The Permutit Company, 440 Fourth Ave., New York, N. Y.

(69) ENGINEERING—Reprint 471, 40 pages "Engineering Achievements, 1931." Reprinted from the January, 1932 issue of the Electric Journal.—Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

(70) ILLUMINATION—Bulletin, 28 pages, "Planned Lighting," a manual for planning almost every form of illumination.—Curtis Lighting, Inc., 1123 W. Jackson Blvd., Chicago, Ill.

COMING EVENTS

Air Conditioning Conference—To be held at Case School of Applied Science, Cleveland, Ohio, March 17 to 19, 1932. Professor G. L. Tuve is general chairman. The meeting is sponsored jointly by Case School and the Cleveland Engineering Society.

American Gear Manufacturers Association—16th Annual Meeting, Cleveland, Ohio, May, 1932. Secretary, T. W. Owen, 3608 Euclid Ave., Cleveland, Ohio.

Illuminating Engineering Society—26th Annual Convention, New Ocean House, Swampscott, Mass., during the week of Sept. 26th, 1932. Assistant Secretary, Frank G. Horton, 29 West 39th, New York, N. Y.

Painting Practice for Wood

THERE are marked variations in the durability of paint coatings on different kinds of woods. The Forest Products Laboratory, maintained at Madison, Wis., by the Forest Service, U. S. Department of Agriculture, in cooperation with the University of Wisconsin, began in 1924 an experimental study of the painting characteristics of soft woods in order to obtain reliable data for the industry.

Results of the 1924 Tests

Summer Wood and Spring Wood

The variable behavior of paint coatings on the softwoods is due primarily to difference in behavior on summer wood and spring wood. Failure of aged coatings in integrity usually begins over summer wood long before it sets in over the neighboring spring wood.

Summer wood is the harder, darker-colored part of the annual growth ring in the wood. Structurally it differs from spring wood in that the wood cells are flattened and have thicker walls and smaller cavities than the wood cells in spring wood, and is roughly three times as heavy. Experience in impregnating wood with liquids proves that the heavy summer wood is more easily and deeply penetrated by liquids than the light spring wood. Experiment shows that the liquids in oil paint follow the same general rule and penetrate more deeply into summer wood than they do into spring wood, although there has long been a contrary impression among painters. The pigments of oil paint are too large to penetrate beyond the cavities of those wood cells that were cut open in forming the surface of the board. Like other liquids, resins exude more easily from summer wood than they do from spring wood, but there is no evidence that summer wood actually contains more resin than spring wood.

Aged coatings apparently do not adhere to wood substances as glue does, but cling to the wood by a mechanical embedding of the paint in the open cell cavities at the surface, much as plaster clings to lath. Summer wood, with its small cavities, furnishes inadequate anchorage so that small pieces of aged coating easily become detached and fall off. However, if the band of summer wood is very narrow, the little pieces of coating may retain sufficient grip in the spring wood on either side to remain in place, arching over the summer wood.

Some Woods Require More Effective Protection Than Others

Some woods require more adequate paint protection to prevent wood-checking, which is the first sign of wood weathering, than others. Test

Abstracted from Report WDI-53-7, p. 53, Trans., A.S.M.E., May-August, 1931, presented by Dr. F. L. Browne, Senior Chemist, Forest Products Laboratory.

TABLE I. CLASSIFICATION OF WOODS FOR PAINTING

Characteristics and the Annual Production of These Woods as Lumber

Classification, Using U. S. Forest Service Common Names	Percentage of all softwood lumber cut in 1927
Group 1—Woods on which coatings served longest, both in integrity and in protection:	
Cedar, Alaska	
Cedar, Port Orford	1
Cedar, Western red	
Cypress, Southern	2
Redwood	2
Group 2—Woods on which coatings failed in protection sooner than on woods of Group 1:	
Pine, Northern white	5
Pine, Western white	
Pine, sugar	1
Group 3—Woods on which coatings failed in both integrity and protection sooner than on woods of Group 1:	
Fir, white	1
Hemlock, Eastern	7
Hemlock, Western	
Pine, Western yellow	10
Spruce, Eastern	2
Spruce, Sitka	
Group 4—Woods on which coatings failed soonest, especially in integrity:	
Douglas fir	30
Larch, Western	1
Pine, Southern yellow	38

Painting Practice for Wood

(*Continued from the preceding page*)

panels were often observed in which the wood had begun to check although the coating otherwise seemed to remain intact. The woods on which this happened were the kinds that quickly develop conspicuous checks and cracks when exposed to the weather without paint protection. Frequently the wood checks became centers from which failure of the coating in integrity progressed.

Edge-Grain and Flat-Grain Boards

Edge-grain boards weather-check less easily than flat-grain boards, doubtless because they swell and shrink less in width, and therefore coatings continue to furnish sufficient protection longer on the edge-grain boards.

Bark Side and Pith Side of Flat-Grain Boards

One side of a flat-grain board is always nearer the bark and the other nearer the pith of the tree from which it was cut. The bark side makes a better surface for painting than the pith side. On the pith side of some boards the summer wood of one annual ring may separate from the spring wood of the next ring, and curl upward in a sharp, easily splintered edge. Paint coatings are often unable to prevent such grain shelling, and consequently the coating may be badly disrupted.

Density and Ring Width

Paint fails sooner on heavy boards, because they contain more summer wood than light ones. However, another factor must also be considered —namely, the width of the annual growth rings (usually recorded as the number of rings per radial inch of the log). When the growth rings are narrow (many rings per inch), there may be a fairly high proportion of summer wood, and yet the bands may be narrow. Such wood holds paint better than wood of equal or slightly lower density in which the growth rings, and consequently the bands of summer wood, are wide.

Any classification of species with respect to painting characteristics is a rough approximation at best and involves much over-lapping; that is, light, narrow-ringed boards of a given species may be superior, from the point of view of painting, to heavy or wide-ringed boards of species assigned higher positions in the classification. In general, edge-grain boards of any species are as good or better for painting than flat-grain boards of the species assigned to the next higher class. Subject to these reservations, the softwoods were classified for painting characteristics on the basis of the 1924 tests as set forth in Table 1, which lists also the relative amounts of the species cut into lumber in 1927.

Lumber Grades

The principal defects that form the basis for grading lumber are also disadvantageous from the point of view of painting. Coatings over knots often discolor, crack, and fall off, and the wood of the knots checks conspicuously. Pitch often exudes through coatings over pitch pockets, pitch streaks, or pitchy wood. Low-grade lumber is therefore less desirable for painting than high-grade lumber of the same species unless the low-grade lumber is remanufactured in such a way that the defects are cut out. Even then the advantage may still lie with the high-grade lumber, because as a rule the high-grade lumber is cut from the outer portions of the log where the growth rings are usually narrower than they are nearer the center of the log.

Heartwood and Sapwood

No consistent differences in the behavior of coatings on heartwood and sapwood have been observed so far.

Extractive Substances Characteristic of Species

Although the primary cause of variation in the behavior of coatings on different species is found in the amount and distribution of summer wood, a factor of secondary importance is the presence in certain woods of characteristic substances that can be separated from the woods by extraction with suitable solvents. Thus cypress and redwood each contain a substance, peculiar to the species, that affects the behavior of paint. When paint is applied to either of these woods while they are wet with water, the coatings will not harden until the moisture content has been reduced to a reasonable amount. On the other hand, coatings cling to the summer wood of redwood and cypress somewhat longer than they do to the summer wood of most other species. It seems likely that the extractives in redwood and cypress have a favorable effect on the durability of coatings.

(*To be concluded in the March issue*)